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The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

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A TYPICAL AMERICAN VILLAGE CENTRAL STATION

Electric Lighting Plant at Odell, Illinois.

The accompanying illustrations, Fig. 1 to Fig. 5, show the engine unit, boiler equipment, and exterior of a typical electric central station installed in American towns and villages, and Fig. 6 shows the wiring connections of the electrical generator booster, storage battery, and switchboard. This electric lighting plant has many up-to-date features and was designed for 24-hour service for supplying current for power purposes and electric lighting of the town of Odell, Illinois, which has somewhat over one thousand inhabitants. This small American central station is operated by the Odell Eelectric Co., and in addition to supplying current all night for lighting service, operates continuously during the day for serving the residences with current for electric fans, electric sewing machine motors, coffee grinders, and other domestic labor-saving devices, as well as for serving current for small motors operating dental apparatus, small printing presses and other machines in the business places of the town.

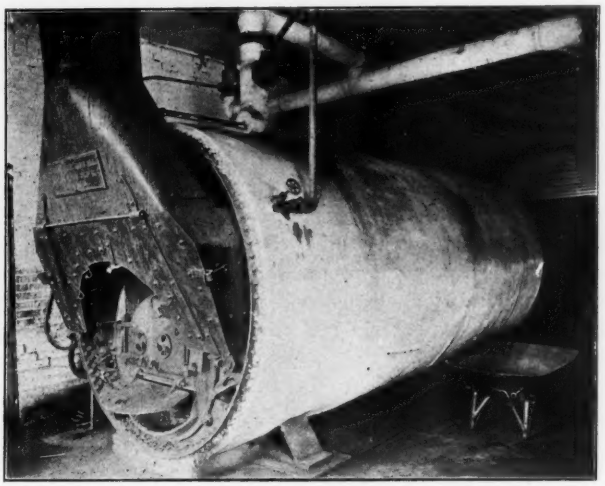


Fig 1.

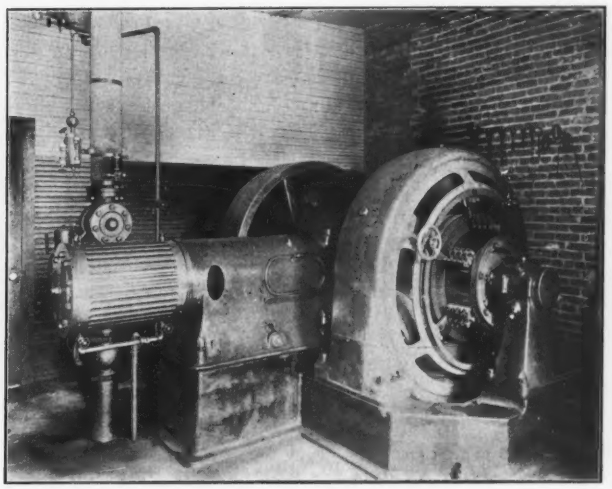


Fig. 2.

This central station, in addition to providing an electric lighting plant, also includes the pumping equipment for the water works system of the town. One of the boilers is shown in the accompanying illustration, Fig. 1, and is of the Scotch marine type, provided with an Adamson furnace. One of the engine and generator units, which is of the horizontal high-speed direct-connected type is shown in Fig. 2, and has a normal capacity of 100 horse power, but is capable of developing 112 horse power at ¼ cut-off. It is a 13" x 14" simple Ball engine, the steam being admitted through an Austin separator, while the condensation water is carried to a Cochrane heater of 150 horse power capacity after being collected by a trap. The feed water is pumped to the boiler after passing through this heater, the temperature of the water being raised by the exnaust steam from the engine. The feed-water is pumped by a 4 x 6 single-acting Dean pump and a 6 x 4 x 6 inch duplex pump of the Worthington type. The boiler has recently been equipped with a stoker of the Little Giant type provided with a hopper into which the coal is shoveled and automatically fed down, falling through rows of separating fingers on the bars. The chimney stack is 50 feet high and is constructed of steel.

The electrical generator consists of a direct-current shunt wound machine of 75 kilowatts capacity directly connected to the high-speed engine and supplying a continuous current of 250 volts to the storage battery, shown in one of the illustra-

tions, Fig. 5, the connections of the same being noted in the wiring diagram, Fig. 6. The switchboard, shown in Fig. 3, includes three panels with the necessary voltmeters, ammeters, wattmeters, switches, and rheostats. The distribution panel is

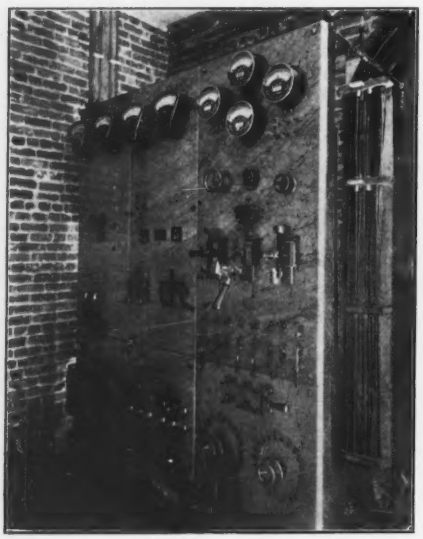


Fig. 3

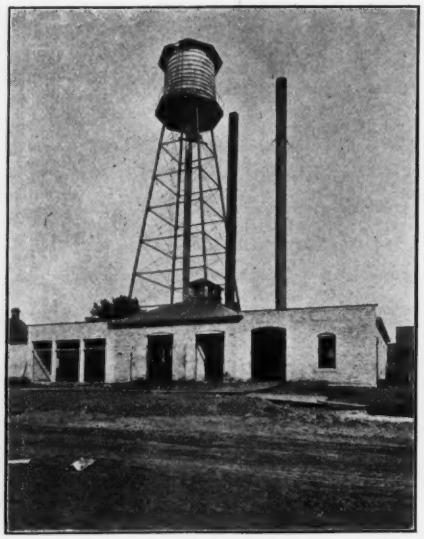


Fig. 4

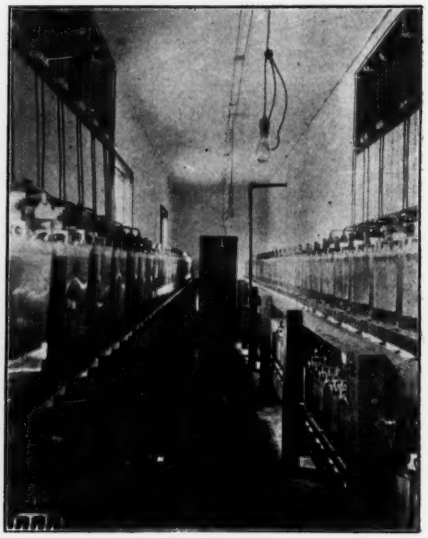


Fig. 5

located in the centre, the storage battery panel with its instruments and switches for measuring and controlling the current of the booster being mounted at the right.

The storage battery includes 124 cells of the Gould type, arranged in two sections on the three-wire system with 21 cells at the ends for regulation. Each element consists of 11 plates, having a total area of 411 square inches per plate. The battery has a capacity of 25 amperes discharge for twelve hours and when discharged in three hours will supply 50 amperes. The potential of each storage cell when fully charged is 2.63 volts, and the regulating apparatus includes an underload and overload circuit breaker for the booster, as well as the necessary switches, ammeters, and voltmeters for the booster and battery equipment.

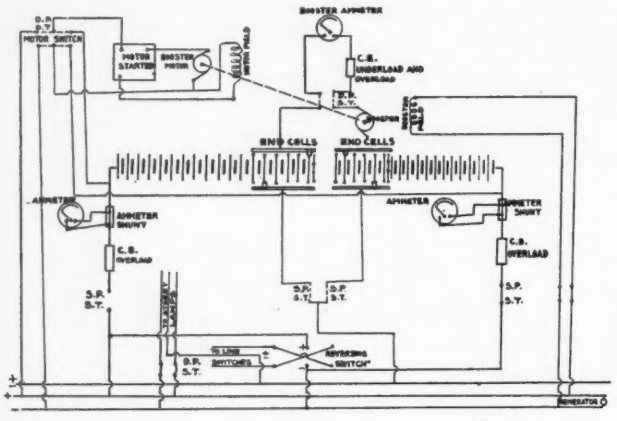


Fig. 6

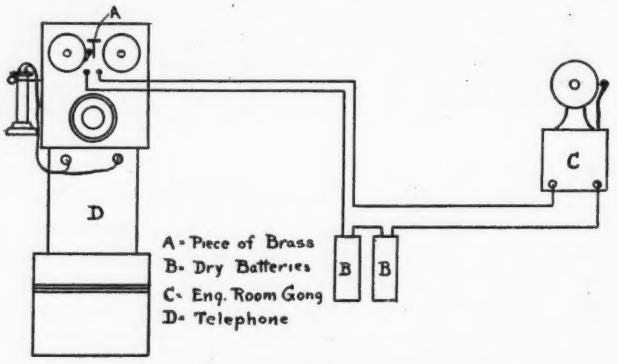
There are 25 arc lights used for street lighting and an incandescent load of about 3000 lamps, all of the lights except the street lamps being supplied with current by meter. The rate charged for current at this small station is from 10 to 15 cents per kilowatt hour according to the quantity of current used.

The water tank noted in the illustration, Fig. 4, is mounted 120 feet and is filled continuously from a reservoir to which the water is pumped by means of a 12" x 14" air compressor of the Ingersoll-Sergeant type. The water is lifted into the reservoir by this compressor from a well 1291 feet deep.

Device for Engine-Room Telephones.

EDITOR THE PRACTICAL ENGINEER:

I noticed among many valuable articles in the October number, a telephone device arranged so that if you were in your boiler-room you could be notified by an electric bell that you were wanted in the engine-room. The device shown in that issue is very simple, yet I believe it is not so simple as the one I use in my engine-room, which is shown in the accompanying illustration. The strip of brass like the letter T which is marked A has a notch in it which is caught on the



Connection for Engine Room Telephones

vibrator and when the engine telephone rings, the T is dropped down onto the two binding posts, thus making a contact and ringing bell in boiler-room.

Toronto, Canada. F. H. C.

621.05 V.10

AUXILIARY POWER AND HEATING EQUIPMENT

By A. S. Atkinson.

The development of the power or heating plant follows certain lines which are generally recognized in standard practice, but local conditions must, after all, largely determine the character of the designs of installation. The engineer who can adapt his plans to the specific needs of each plant so as to secure the highest economy of operation and efficiency along with simplicity of design must represent the best achievement of the day. In a great many plants of today, the question of economy and efficiency of operation is involved in a complexity of minor details of equipment that are more or less puzzling. The modification of the equipment must therefore be considered step by step as the installation proceeds, or otherwise economy and reliability may not be secured to such an extent as to justify elaborate designing.

A safe rule adopted by the best engineers is to use only such apparatus in a plant as can show a profit on the investment. This rule rigidly adhered to may add a great deal to the work and troubles of the designer. When it comes to the adoption of auxiliary equipment, the engineer may be excused at times for not following out the rule in all details. On the other hand, if he can demonstrate the profitableness of each additional equipment he will secure results which will go a long way toward increasing profits and economy of operation.

In electric railway and electric lighting plants, the auxiliaries are absolutely needed. The load varies so much and so constantly that the auxiliaries are of paramount importance. Yet the auxiliaries are invariably operated inefficiently and at a loss. They must be prepared to care for the maximum load at any time, and they must be operated inefficiently during most of the time when the load is far below the maximum. In fact, the average load is considerably less than the maximum three-quarters of the time, and as the auxiliaries are operated at a constant load, they are worked most of the time at a loss.

Nevertheless, their use is imperative, and their installation is as absolutely essential in many plants as the steam boiler. The number of auxiliaries in use depends to a large extent upon the fuel problem. Where fuel is very cheap, the auxiliary equipment is much less than in regions where coal is high. Economy in fuel in the latter places is the first important step, and this must be obtained through the use of rather elaborate and complex auxiliary equipment. The expense of installation is naturally greatly increased by the equipment with such refined economizers, but in the end they justify such extra investment. They pay for themselves, and show a distinct profit on the initial cost of investment.

Distinction should be made between railway and electric light plants where auxiliaries are required to care for the maximum load and the plants which require auxiliary machinery chiefly for the purpose of economizing in fuel. In the former power houses, the auxiliaries are only operated at a point sufficient to take care of the maximum load, and their steam consumption per unit of output varies indirectly as the load on the main engines. Up to a certain point, the amount of steam used by the operation of the auxiliaries will show no loss, but when the prime movers are running light loads, the auxiliaries are run unprofitably. The percentage of loss will increase rapidly as the load on the main engines decreases. Usually not more than twelve per cent. of all the steam generated can be profitably used for operating the auxiliaries. Anything above this shows reduced efficiency of the prime movers, and where the plant is run under light loads for long periods the loss is bound to amount to considerable.

The question of governing the auxiliaries automatically is one of the most important of the day in plants where the load varies rapidly and greatly. Very little effort has been made in this direction in the ordinary plant. The reason for it is partly due to the many larger questions calling for solution. The automatic control and operation of the auxiliaries naturally increases the complications of the design, and engineers today are seeking simplicity rather than complexity of installation. Such automatic control, whether from the engine governor or a generator controlling device, must prove its worth by showing a higher profit, or else its existence in the modern engine room is not to be tolerated. At present, the loss in the operation of auxiliaries is sometimes so great that engineers discard them wherever and whenever possible. As a result, a good many plants fail to achieve the highest efficiency.

The modern engineer must secure reliability first in his plant, then economy of operation, and finally simplicity of design and control. In many instances these necessary steps are reversed. Simplicity is considered first, and while this may be achieved, reliability and economy of operation are both sacrificed. Reliability must be secured at all hazards. A plant that is not thoroughly reliable in every particular may as well not be in existence. Its use is of little value. Whether in electric lighting service, railway use, or manufacturing, the machinery, engines, boilers or motors that do not possess reliability are not worth the cost of the iron and steel which enter into their composition. Therefore, the design which aims at simplicity at the expense of reliability is a fatal blunder.

The same can be said to a large extent of the plant which sacrifices economy of operation for simplicity. It is much better to add all the auxiliaries in the market to secure greater efficiency and greater economy. Economy in fuel consumption is not everything. Sometimes this is obtained at too great an expense. The initial cost of installation, and the complications of parts, may be so great as to more than counterbalance any gain. The construction of the plant so that it will avoid any of the mistakes so common where prominence is given to any one of these three factors at the expense of the others is of the utmost importance; but to secure such a balancing of conditions every detail must be considered in advance. The plant must be designed according to the work demanded of it, and also according to the cost of fuel and such local conditions as room for machinery, cost of labor, and possible extension of the plant in the near future.

The preheating of feed water and the use of mechanical and chemical purifiers have become pretty general in many parts of the country in large plants, and their introduction, while increasing the complexity, has demonstrated the value of auxil-

iaries rightly designed and operated. There can be no doubt that they perform their work profitably in many plants. The variety of purifying apparatus has caused confusion in some quarters, and has made it doubly difficult for engineers to adopt the best for all conditions. However, this question is settled chiefly by a study of the character and needs of the plant in connection with local conditions. The feed water differs materially in various parts of the country, and the destructive effects of acids in the water must be considered as well as the scale-forming ingredients. In one part of the country the feed water requires little treatment other than filtering and preheating, but where scale-forming ingredients and iron salt acids are present in large quantities, purifying the water is a matter of absolute economy. The corrosion of the boilers by the acids is not less expensive in the end than the waste of fuel required to produce a given amount of steam from boilers whose interiors are heavily encrusted with scale. Usually the apparatus for purifying and preheating the feed water adds so materially to the initial cost that its installation is often an after-thought rather than a part of the original design. Where such apparatuses will save from five to ten per cent. of coal bills, or add ten per cent. to the efficiency of the boilers, or extend their natural life of usefulness four or five years, their installation is justified, and modern engineering practice recognizes the fact.

Standard types of boilers for power houses and central electrical stations have received such improvements in recent years that it seems doubtful if they can be changed much more for the better. It is not unusual to secure under ordinary conditions from seventy-five to eighty per cent. efficiencies from such standard boilers. They are so well constructed and designed that the saving of fuel over old types of boilers is very great. The question of strengthening the boilers in this work by bringing up all other parts of the plant to a similar high degree of efficiency is one of the problems which central engineers face today.

The preheating apparatus, feed-water purifiers, fuel economizers, and mechanical stokers all perform their particular functions in this respect, and they are designed to aid the boiler in its output, and to contribute to the general efficiency of the whole plant. Mechanical stokers in large plants are requisite, and where the plant is large enough they increase the efficiency and economize in fuel over any hand-firing method. It is possible in small plants for good firemen to show as high efficiencies in hand-firing as mechanical stokers, but such results could hardly be secured on a large scale where uniformly good firing is essential to success. It is difficult to secure firemen in large plants who take their work seriously enough to show equally high results. It is this very problem of securing skilled firemen in the boiler room that is causing the adoption of mechanical stokers even in small plants where good hand-firing could be done comparatively cheap.

The character of the fuel and its consumption must always determine to a large extent the designs of a central station or power house of any kind. More and more is this question of utilizing cheaper fuels entering as a determining factor in our industries. Clean anthracite coal is easily burned, and it can be satisfactorily burned in almost any kind of grate and under any type of boiler. But anthracite coal is very expensive in many manufacturing centres, and its use is greatly restricted. The tendency is to cut away from it so far as possible. Bituminous coal, peat, oil and refuse have all be experimented with as substitutes for anthractie; but in all these cases it has been found that such substitutes must be burned in specially-designed grates.

The furnace and grate must therefore be designed for a specific purpose. The nature of the fuel to be used must be considered at the outset. We have made great advances in the last few years in designing grates for burning semi-bituminous and bituminous coals and lignites. We have also nearly perfected the oil-burning grates so that liquid fuel can be used under boilers without danger of explosion and without any apparent waste through imperfect combustion. The greatest loss in burning these cheaper fuels is from imperfect combustion of the volatile gases released from the coals. These are distilled very rapidly, especially when fresh fuel is added to the fire, and their tendency is to escape up the chimney before ignition. It is only when the proper temperature can be supplied in connection with sufficient air that the gases are ignited and properly burnt.

One of the most important signs of improvement in this direction is the regular analysis of the flue gases made in large power companies today for the purpose of ascertaining the amount of loss sustained in imperfect combustion. Such investigations are not carried on for purely theoretical purposes, but for practical ends. The analysis is intended to help in the correction of burning the fuel. Even in the best designed furnace and grate for burning bituminous coals, the right proportion of air admitted and the heat generated in the furnace will not prove uniform. Everything depends upon the engineer in charge who is able to apply the correction needed. An admission of an excess of air to the furnace may very easily nullify all the good effects of the best designed grates, and similarly a too small proportion of air causes a loss. Until we can automatically regulate such mixture of air with the volatile gases released, and raise the temperature of the furnace to the point where ignition is steady and continuous, the need of proper precaution on the part of engineers in controlling the draft will be imperative. The ideal plant should be one where combustion could be automatically regulated so that the percentage of loss would be reduced at all times to a minimum.

An excess of cold air through the furnace will often cause gases to escape at a low temperature. Ordinarily, low temperature gases escaping from the flue are considered important as indicating perfect combustion and efficient furnace conditions. Such signs are not to be relied upon, for a steady leak may be going on, due to a strong draft of cold air. The only way to ascertain the exact condition of the combustion is to analyze the flue gases. This tells the true story so that the proper corrective can be applied. Too little of this is being done today in the average plant. It is not considered important enough, except in the large power houses where fuel consumption mounts up to enormous items of expense, but a capable engineer could easily prove to his own satisfaction that many losses now neglected could be eliminated by regular analysis of flue gases and the proper control of the draft as indicated necessary by the examination. More intelligent burning of soft coals is today one of the questions that needs thorough examination and general data upon which to base calculations.

METHODS OF KEEPING POWER PLANT RECORDS

A Model System as Employed at the St. Regis Hotel, New York City

To be an engineer of a large power house at the present time or to be in charge of a plant where many and various different kinds of machinery are installed means that the man occupying this responsible position must not only be thoroughly acquainted with the uses and the mechanism of all the apparatus installed, but he must also be able to keep an account, in a business-like manner, of the performance of the plant, so that the cost of maintenance of each piece of machinery, cost of the oil, cost of the fuel, cost of the labor and various other important items may be known at any time.

To be able to do this successfully involves an immense amount of thought, so that the data secured may be in such shape as to be always available. The kinds of records and the data which will be required will vary with the kind of plant and must be evolved by the engineer in charge to meet the exigencies of the occasion.

The modern hotel, as it stands today, contains probably the greatest array of machinery that can be found in any one plant. The apparatus of such a plant includes boilers, engines, dynamos, pumps, refrigerating engines, elevators, ventilating and heating systems, pneumatic tube system, feed water heaters, filters, sewage ejectors, air compressors, electric lights, electric clocks, telephone system, machine shop, oiling system and many other smaller details just as important. To keep a record of all these things without confusion necessarily means that an engineer must have business ability, as well as mechanical ingenuity.

A model system which has been worked out perfectly during the past two years is that employed at the St. Regis Hotel, New York City, and is the result of the labors of J. C. Jurgensen, chief engineer, to whom we are indebted for much of the information found in this article. The value of keeping a complete record of the performance of the plant has been demonstrated to him time and again and he is an enthusiastic advocate of it. For instance, it was found on one occasion that for some apparently unaccountable reason, the cost of the water used in the building jumped up thirty-one dollars per day over what it had previously cost per day. This was indicated by the reading of the water meter. Upon looking up the records, it was found that the one house pump had run a very much greater number of strokes than normal for the day in question.

Calculating backwards, it was found that the amount of water lost was equivalent to a flow of water through a one-inch pipe for 24 hours. An inspection of the one-inch pipes throughout the building showed that a plumber had left a one-inch valve open on one of the floors where he was working and the water was escaping unnoticed. Illustrations of the

HOTEL ST. REGIS.

ENGINEER'S DEP'T.

Daily Pump Report. Date_____

NO.	SIZES IN INCHES	STARTED OR STOPPED AT A. M. 12	2	4	6	8	10	P. M. 12	2	4	6	8	10	AMOUNT OF WORK: RAN HOURS	COUNTER READINGS WHEN STOPPED	TOTAL STROKES	PACKED: RODS STEAM	RODS WATER	PISTON STEAM	PISTON WATER	REMARKS
1	4 x 5 x 4																				
2	4 x 5 x 4																				
3	8 x 7 x 12																				
4	8 x 7 x 12																				
5	6 x 4 x 6																				
6	6 x 4 x 6																				
7	14 & 20 x 11 x 15																				
8	14 & 20 x 11 x 15																				
9	14 & 20 x 11 x 15																				
10	14 x 7½ x 12																				
11	14 x 7 x 10																				
12	14 x 7 x 10																				
13	7½ x 6 x 10																				
14	7½ x 6 x 10																				
15	7½ x 5 x 6																				
16	7½ x 5 x 6																				
17	6 x 4 x 6																				
18	6 x 4 x 6																				
19	7½ x 5 x 6																				
20	7½ x 5 x 6																				
21	4½ x 2¾ x 4																				
22	Well Pump.																				
23	Centrif. Pump.																			O. K. ENGINEER	

value of keeping complete records can thus be multiplied, but space will not permit.

The St. Regis Hotel is admirably equipped for keeping complete records, since it contains three water meters, weighing devices for coal, recording wattmeters, recording instruments for steam pressures, feed water temperatures, heating returns, chimney returns, hot water returns, outside temperature, back

HOTEL ST. REGIS

Engineer's Dep't.

Meter Readings

DATE Time of Reading, 12 P. M.

MAN'F'R'S NO. OF METER	HOUSE NO.		SUPPLIED FROM	READING	AMT. CUBIC FT.
200048	WATER METERS	1	8 IN. MAIN ON 55TH ST.		
200334		2	48 IN. MAIN IN 5TH AVE.		
200316		3	16 IN. MAIN IN 5TH AVE.		
TOTAL CUBIC FT. WATER USED					

MAN'F'R'S NO. OF METER	HOUSE NO.		SUPPLIES	READING	AMT. CUBIC FT.
230888	GAS METERS	1	GAS LOCKS		
307891		2	1ST & 2ND FLOOR PUBLIC ROOMS		
339134		3	15T TO 17TH FLOORS GUEST ROOMS		
667140		4	KITCHEN COOKING		
678468		5	HALLS, CORRIDORS SERVANTS' QUARTERS		
671077		6	TAKING E. & W. PANTRIES E. & W. MEZZANINE BARS		
847721		7	KITCHEN EAST		
498439		8	SUB-BASEMENT		
TOTAL CUBIC FEET GAS USED					

REMARKS:

SIGNED

pressure and temperatures on five tempering fans. The following is a list of things which the records tell about the operation of the plant:

Mechanical dept. men—total number.....
Total number days worked .....
Average daily wages per man.....
Number of men in boiler plant.....
Total salary in " " .....
Dynamo and engine departments.....
Total salary .....
Total horse power developed.....
Total tons coal burned.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Actual average ratio water to coal per month.....
" " " 1st watch .....
" " " 2d " .....
" " " 3d " .....
Ratio water to combustible per month.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Ratio from and at 212° per month.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Average price per ton coal 2000 lbs.....
Kind of coal used and conditions.....
Daily average cost of coal used by our weight.....
Estimated cost of loss in weight.....
Total cost of coal in month according to our weight.....
Total cost per horse power developed in month without interest and depreciation .....
Total cost per horse power developed in month with interest and depreciation .....
Number of men employed electric generated plant.....
Total salary in month.....
Total cost per kilowatt hour generated in month without interest and depreciation.....
Total cost per kilowatt hour generated in month with interest and depreciation.....
Total amount water received from city in month.....
Daily average " " " " .....
Total amount water evaporated by boilers.....
Daily average to boilers.....
Daily average used by plumbing.....
" " " ice machine .....
Total cost of machine oil in month.....
" " cylinder oil " .....
" " kerosene oil " .....
" " liquid base " .....
" " sperm oil " .....
Total cost of all oil used in month.....
Daily average cost of oil.....
Total cost of cotton waste.....
Daily average cost of cotton waste.....
Total horse power developed in month.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Daily average horse power developed in month.....
" " " " " 1st month ...
" " " " " 2d " ...
" " " " " 3d " ...
Daily average feed water temperature in month.....
" " " " " 1st watch ....
" " " " " 2d " ....
" " " " " 3d " ....
Total lbs. water evaporated in month at average temperature..
Daily average lbs. water evaporated " " " ..
Total lbs. water evaporated in month.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Total tons coal burned according to our weight.....
" " " " " " 1st watch .....
" " " " " " 2d " .....
" " " " " " 3d " .....
Daily average tons burned.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....

HOTEL ST. REGIS

Engineer's Department

HEATING AND VENTILATING MOTORS.

Date Time of Readings

Motor No.	Location	Supplying	Rev. per min.	Temperature Record. Therm.	Temperature Regular Therm.	Number of Valves Open	Remarks
1	SUB BASE.	KITCHEN AND MEZZANINE FLOOR					
2	SUB BASE.	1ST FLOOR					
4	SUB BASE.	RE-HEATING STACKS					
7	E. MEZ. FL.	PUBLIC ROOMS 2D FLOOR					
8	3 FL.	4TH TO 7TH FLOORS INCLUDED					
9	7 FL.	8TH TO 12TH FLOORS INCLUDED					
10	12 FL.	13TH TO 17TH FLOORS INCLUDED					
Exhaust Motors				Kind of Weather			
11	19 FL. EAST	FIRE PLACES EAST		Sunshine		High Wind	
12	19 FL. EAST	3-19 FLOOR, EAST		Rain		Medium Wind	
13	19 FL. WEST	KITCHEN		Cloudy		Light Wind	
14	19 FL. WEST	FIRE PLACES, WEST		Outside Temperature ..... Fh.			
15	19 FL. WEST	3-19 FLOOR, WEST		Outside Humidity ..... Per Cent.			
				Back Pressure ..... Lbs.			

SIGNED

Total lbs. ash removed.....
Daily average per cent. ash in coal—total.....
Daily average per cent. ash in coal—1st watch.....
" " " " " 2d " .....
" " " " " 3d " .....
Average chimney temperature.....
" " " 1st watch .....
" " " 2d " .....
" " " 3d " .....
Average outside temperature.....
" " " 1st watch .....
" " " 2d " .....
" " " 3d " .....

Average back pressure.....
" " " 1st watch .....
" " " 2d " .....
" " " 3d " .....
Average number sq. ft. grate surface in use per day.....
Average chimney draft in inches.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....
Average load factor on boilers.....
" " " " 1st watch .....
" " " " 2d " .....
" " " " 3d " .....

HOTEL ST. REGIS
Engineer's Dep't.
ICE MACHINE REPORT

Date 12 P. M. to 8 A. M. WATCH NO. 1.

HOURS	MACH.	PRESSURES				TEMPERATURE OF CONDENSING WATER		BRINE COOLERS				TEMPERATURE OF BRINE RETURNS			BRINE PUMPS								CHAMBER TEMPERATURE		CANS ICE PULLED
		STEAM		AMMONIA		IN	OUT	NUMBER		TEMPERATURE		H. P.	L. P.	ICE CREAM BOX	ICE STREAM Freezer	NUMBER			PRESSURE		AV. STROKES PR. MIN.				
		1	2	H. P.	B. P.	CAN. D. P.			1	2	IN	OUT							H. P.	L. P.	H. P.	L. P.			
A. M.	1																								
	2																								
	3																								
	4																								
	5																								
	6																								
	7																								
	8																								

	STATE OF METER	CUBIC FEET USED	SPEC. GRAVITY	OIL USED		ENG. NO.	STARTED
WATER			SODIUM CHLORIDE	CYL.	QTS.	" NO.	STOPPED
AMMONIA			CALCIUM	ENG.	"	" NO.	STARTED
BRINE				L.O. BASE	"	" NO.	STOPPED
REV. OF ENG.	NO. 1		STREET WATER PRESSURE	24H. AVG.	TOTAL TIME RUN, H'RS	MIN.	
	NO. 2			10H. ST.			

REMARKS.

O. K.
Engineer.

Cost per 1000 lbs. water evaporated in month.....
" " " " " " " 1st watch .....
" " " " " " " 2d " .....
" " " " " " " 3d " .....
Average ratio water to coal in month.....
" " " " " 1st watch .....
" " " " " 2d " .....
" " " " " 3d " .....
Average ratio water to combustible in month.....
" " " " " 1st watch .....
" " " " " 2d " .....
" " " " " 3d " .....
Average ratio water to coal from and at 212° in month.....
" " " " " " 1st watch .....
" " " " " " 2d " .....
" " " " " " 3d " .....
Total kilowatt hours generated in month.....
Daily average kilowatt hours generated in month.....
Total kilowatt hours generated for light in month.....
Daily average kilowatt hours generated for light.....
Total kilowatt hours generated for power in month.....
Daily average kilowatt hours generated for power.....
Daily average number of 16 candle horse power lamps hours used for light .....
Boiler horse power equal to daily average kilowatt hours.....
Daily average kilowatt hours generated for light—1st watch..
" " " " " " 2d " ..
" " " " " " 3d " ..
Daily average kilowatt hours generated for power—1st watch..
" " " " " " 2d " ..
" " " " " " 3d " ..
Average number lbs. steam used by engine per horse power hour
Daily average strokes of electric pumps.....
Daily average strokes of low pressure boiler pumps.....
" " " high " " " " .....
" " " house pumps .....
" " " sweeper machine .....
" " " pneumatic machine .....
" " " ice machine .....
Total cost of gas .....
Daily average cost of gas.....
House department mechanics—total number.....
Total days worked .....
Total salary house department, mechanical.....
Daily average wages per man.....
Elevator operators—total number.....
Total salary elevator operators.....
Daily average wages per man.....

Cost of material used—stationary.....
" " " miscellaneous .....
" " " boiler plant .....
" " " engines .....
" " " heat and ventilation.....
" " " refrigeration .....
" " " electric system .....
" " " hydraulic elevator .....
" " " electric dumbwaiter .....
" " " plumbing .....
" " " tool maintenance .....
" " " oiling system .....
" " " auxiliary machines .....
" " " sundries—mechanical department ....
" " " old stoves repair .....
" " " mechanical department improved.....
Total cost material used in mechanical department.....
Daily average cost of material used in mechanical department..
Cost of material used for altering and repairing.....
" " " lighting .....
" " " laundry .....
" " " in bars .....
" " " kitchen .....
" " " public rooms .....
" " " guest rooms .....
" " " renovation .....
" " " sundries .....
" " " house department improvements.....
Total cost of material used in house department.....
Daily average cost of material used in house department.....
True cost of labor in mechanical department.....
Cost of routine labor in mechanical department.....
True cost of labor in house department.....
Cost of routine labor in house department.....
Total cost of all material used from mechanical stoves.....
Daily average cost of all material used from mechanical stoves.
Total number men employed for elevators, house mechanical and mechanical departments .....
Total salary for all men.....
Daily average salary for all men employed.....

As will be noticed, there are three watches in the engine room and boiler room, there being an engineer in charge of each watch. On weekdays the watches are as follows:

1st watch from 12 midnight to 10 A. M.

2d watch from 8 A. M. to 6 P. M.

3d watch from 4 P. M. to 2 A. M.

The incoming watch at once relieves the outgoing watch, the two-hour lap being used for repairing and cleaning. The

HOTEL ST. REGIS.

ELEVATOR REPORT. Engineer's Dep't.

DATE Watch No.

ELEVATOR	VALVE CUPS REMOVED		PACKING		OILED								INSPECTED			CANDLE CUPS FILLED TRIMMED			CARS PAINTED	BLOWER LIGHTS					
	OPERATING	PILOT	PISTON	PISTON ROD	VALVE STEM	GOVERNORS	OPERATING SHEAVES	OPERATING VALVE	CUT-OFF VALVE	CYLINDER	POWER WIRE	MAIN	TRAVELLING SHEAVES	GOVERNORS	CUT-OFF VALVES	TOP SHEAVES	SAFETY PLANKS	MAIN	TRAVELLING	SUPERVISOR		LIFT	PACKED	VALVE CUPS FILLED TRIMMED	OILED	MAIN FILLED	PAINTED
1																					1						
2																					2						
3																					3						
4																											
5																											
6																											

REMARKS:

SIGNED: O. K.
Engineer

engineer of the second watch is classed as the first assistant engineer and practically has entire charge of the engine room. Mr. Adam Harkness occupies this responsible position, while Mr. James T. Roarty has charge of the third watch and Henry W. Geare has charge of the first watch.

On Sundays, in the engine room, the first watch is off from 8 A. M. Saturday morning to 12 o'clock midnight, Sun-

day; the second watch is off from 4 P. M. Saturday to 8 A. M. Monday and the third watch is off from 12 P. M. Saturday to 4 P. M. Monday. When the first watch goes off Sunday, the second watch works until 7 P. M. Saturday evening and from 7 A. M. to 4 P. M. Sunday, the third watch working from 7 P. M. Saturday to 7 A. M. Sunday and from 4 P. M. to 12 P. M. Sunday.

When the second watch goes off Sunday, the third watch works from 4 P. M. Saturday to 2 A. M. Sunday and from 1 P. M. to 12 midnight Sunday, the first watch working from 2 A. M. to 1 P. M. Sunday. When the third watch goes off for Sunday, the first watch works from 12 P. M. Saturday to 10 A. M. Sunday and from 10 P. M. Sunday to 10 A. M. Monday, the second watch working from 10 A. M. to 10 P. M. Sunday. By this arrangement, each watch has 40 hours off.

In the boiler room, the watches change each week; what was the third watch one week becomes the second watch the next week, and so on. As in the engine room, the first watch is from 12 midnight to 10 A. M., second watch from 8 A. M. to 6 P. M., third watch from 4 P. M. to 2 A. M. As will be noticed, all the watches lap two hours and the work to be done during each lap watch is specified.

During the lap watch from 8 A. M. to 10 A. M. the first watch has the following duties: First and second firemen to blow dust from tubes of boiler assigned to this watch; also clean all steam and exhaust headers and pans, and pans and bases of pumps in pump room. Coal passer to clean and polish all floor sleeves in engine room; also brass work in engineer's room and firemen's toilet. The oiler to go up to all the pantries and see that the steam tables and hot water boilers are in working order; also clean and polish gauge-board. Floor cleaner to clean and polish all cuspidors in engine room and polish plumber gauge board. Electrician's helper to clean all lamps and lamp shades in engine room and engineer's office. Screen cleaner to clean and polish pneumatic and sweeping machines and pans. Engineer to look after everything in kitchen and consult with steward; also report in writing on jobs he wishes to have attended to in kitchen and engine room during the day watch. All reports and finished orders to be left in top drawer of engineer's desk in engine room.

During the lap watch from 4 P. M. to 6 P. M., the second watch has the following duties: The first and second firemen and coal passer to blow dust from tubes of boiler assigned to this watch; also wipe off and polish pumps in pump room. The oiler to clean and drain machine oil filter, have oil extracted from greasy waste and keep waste-saving machine and pans clean. Ice machine attendant to examine and regulate all ice boxes in house, consult the wishes of steward and report conditions of boxes to engineer. Ice puller to clean and polish pumps and pans. Shaft cleaner to clean and polish elevator pumps and pans. Thermostat attendant to clean and polish air pumps for thermostatic service. Pump man to clean and polish air compressors and pans. Second machinist to clean machine shop, wipe off and polish all machines and tanks in shop and keep junk store room in order. First assistant electrician to clean and polish switchboard, bell board and report in writing defects found and suggestions. Electrician to report in writing all jobs he wishes to have attended to during the next day. Engineer to report in writing to engineer's office, all jobs on hand or finished during the day; also on all work which must be attended to the next day and make requisitions for new material needed and not on hand.

During the lap watch from midnight to 2 A. M., the third watch has the following duties to perform: The first and second fireman to blow dust from tubes of boilers assigned to this watch; also clean and polish boiler gauges and all brass work on boiler fronts and oil and clean coal scale and trolley. Coal passer to sweep floor and column bases in blower room; also clean and polish feed water heater, filter and hot water tanks. Oiler to clean and polish all engine governors. Ice machine attendant to clean and polish No. 3 and 4 engine. Second assistant electrician to clean and polish pans of house and fire

BOILER REPORT - WEEKLY RESULTS.

DATE	FIREMAN	COAL BURNED IN POUNDS	WATCH	FEED WATER USED CUBIC FT.	LBS. WATER EVAPORATED FROM & AT 212	No. OF CANS ASHES REMOVED	TOTAL LBS. ASHES REMOVED	RATIO OF WATER TO COAL	PER CENT. ASHES	BOILER H.P.	LBS. COAL PER H.P.	RATIO FROM & AT 212 PER LB. COMB.	COST OF COAL BURNED	COST OF ASHES REMOVED	COST OF 1000 LBS. OF ACTUAL EVAP.	PREMIUM TO FIREMAN	PREMIUN TO BOILER CLEANER
WEEK			1														
			2														
			3														
WEEK			1														
			2														
			3														
WEEK			1														
			2														
			3														

pumps. Engine helper to clean and polish engines No. 1 and 2. Engineer to look after the cylinder oil filter and report in writing on work he wishes to have attended to the next day.

From the above it will therefore be noticed that each watch performs its regular duties for eight hours, after which the other watch comes on and takes charge, thus allowing the outgoing watch to perform its special duties, wash up and get ready to go home. The result of this system is that the plant

BOILER ROOM

REPORT.

Date *Time of reading, 8 A. M.* *Watch No. 1.*

BOILERS	1	2	3	4	5	TEMP. FIRE ROOM		COND. OF COAL		KIND OF COAL
BOILER PRESSURE						COAL FIRED LBS.		DRY		
NO. OF COCKS OF WATER						TEMP. FEED WATER		MEDIUM		
TIME TUBES CLEANED						READING FEED WATER METER		WET		
TIME FIRES CLEANED						DRAFT IN INCHES IN CHIMNEY		GOOD		
TIME FIRES BANKED						TEMP. CHIMNEY GAS		MEDIUM		
CANS ASH REMOVED FROM BACK CONNECTION						CANS ASH REMOVED		BAD		

The above readings to be taken by watch going ON in presence of watch going OFF and BEFORE same is RELIEVED

REMARKS: .....

O. K. .....
Engineer.

is kept in the very highest state of efficiency and gives at the same time easy hours for work. A particular feature which is to be commended and one which gives all the employees of the plant great satisfaction is the fact that if for any reason one of the engineers should leave, everyone along the line down to the oiler or coal passer is moved up a peg, no outsider being employed except for the lowest positions. This gives the men something to work for.

Another feature which is found to give much satisfaction is the "Certificate of Merit" which is rewarded each year. It is a magnificently engraved certificate signed by the chief engineer and is very much prized by the men. The following are the rules which are followed in awarding the "Certificate of Merit":

RULES TO BE FOLLOWED IN ORDER TO GET THE CERTIFICATE OF MERIT

1. Two years' continuous service.
2. The strictest sobriety.
3. Truthful and manly conduct.
4. Punctual in attendance except when unavoidable delays occur.
5. Industrious and always giving the company a full and honest day's work.
6. Strict and willing obedience to orders and compliance with all rules of the company.

In order to be entirely impartial and to give every man an equal chance to gain the Certificate of Merit:

1st. Rule No. 1 will be used as the basis to work from in the following manner: For each week of service 10 points will be given; at the end of two years, a man has 1040 points and to gain certificate he must have not less than 1000 points for two years' continuous service.

2d. If found under the influence of liquor, immediate discharge will follow.

3d. For untruthful and unmanly conduct, deduct 50 points each time.

4th. For each five minutes late in coming in or five minutes early in going out, except when unavoidable delays occurred or when permission is given, deduct 1 point for each five minutes, or fraction of five minutes.

5th. If found shirking and not attending to work as an honorable man would, deduct 5 points each time.

6th. If found to disobey orders of superior and rules of the house wilfully and knowingly, deduct 5 points each time.

As will be noticed, nothing unreasonable has been asked, so that as might be expected, all the employees look forward to the attainment of this very much valued certificate.

Aside from the "Certificate of Merit," the men in the boiler room are rewarded for the economical operation of the boilers. There is a man in charge of the boiler room each watch, called the boiler cleaner, who is always on the same watch each day, so that each week for three weeks he has a different set of men under him. The premium which is awarded to him is therefore based upon the average made by the three sets of men under him. At the St. Regis Hotel, an average of 6.75 pounds of water per pound of coal is taken as the standard of evaporation. If the average for the three weeks, during the watch he is on, exceeds that figure, he is awarded the following premiums:

For ratios between 6.75 and 6.85.....$ .50 a week.
" " " 6.85 " 6.95..... .75 "
" " " 6.95 " 7.05..... 1.00 "
" " above 7.05 ..... 1.25 "

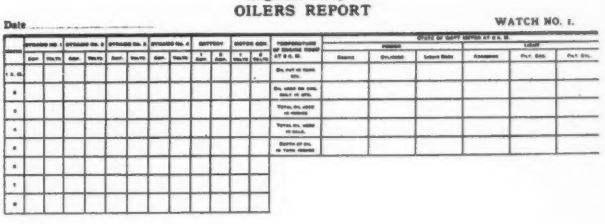
The fireman of each watch gets a premium depending upon the ratio of evaporation for his watch. As, however, the firemen change watches each week and because some watches are easier than others, the premiums are arranged so that if the fireman keeps above the average for all three watches, he gets the first premium, if he keeps ahead for two watches he gets the second premium, and if he keeps ahead for only one watch he gets the third premium. These premiums are as follows:

Between 6.75 and 7.25, 1st premium....$1.50 per week.
" " " " 2d " .... 1.00 "
" " " " 3d " .... .50 "
" 7.25 " 7.50, 1st " .... 1.75 "
" " " " 2d " .... 1.25 "
" " " " 3d " .... .75 "
Above 7.50 1st " .... 2.00 "
" " " " 2d " .... 1.50 "
" " " " 3d " .... 1.00 "

It is needless to say, of course, that economy is the password in that fireroom and that premiums are the rule rather than the exception. Buckwheat No. 2 coal is used for fuel, which is carefully weighed by an automatic weigher. The readings of the amount of feed water are obtained from a water meter, and

HOTEL ST. REGIS
Engineer's Dep't.
OILERS REPORT

Date ..... WATCH NO. 1.



REMARKS .....

O. K. .....
Engineer.

the flue gas temperature is always known in the fireroom, as is the feed water temperature, the recording instruments also verifying these temperatures, so that the plant is always running a boiler efficiency test. The accompanying log sheet shows how the weekly reports are kept and it is from these sheets that the premiums are obtained. The report of each watch each day is handed in on a prepared sheet, which is verified by the watch going on and O. K.'d by the engineer in charge.

The daily pump report gives the time each pump was started and stopped, how many strokes it made and when the rods were packed. The oiler report shows the voltage and current on each dynamo every hour, as well as the amount of dif-

ferent kinds of oil used. The elevator report shows the number of cars running and the attention and repairs given to the nine elevators in the building. The ice machine report includes all the temperatures and pressures in the system and other useful data. The sheet for meter readings shows the amount of water and gas used in the building for different purposes. The temperature report shows the temperature and humidity throughout the various rooms in the building and the heating and ventilating report gives all the useful information about the motors and the kind and temperature of the weather.

These reports are filed in the engineer's office, from which weekly, monthly and yearly reports are compiled by one man who is specially employed for the purpose. From this correlated data curves are drawn which very clearly show how the load varies, how the cost of power varies, and so on, from which at a glance it can be seen where there has been poor firing or where the coal has been bad, etc.

There are many other features about this system which are equally as important and interesting as those shown, but enough fundamental data has been given to enable any engineer who wishes to incorporate such a system in his plant, to start along the proper way.

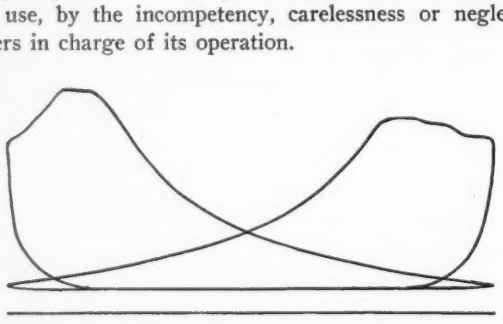
The Practical Value of Indicating the Ammonia Compressor

A paper on the above subject was recently read before the American Society of Refrigerating Engineers, by W. Everett Parsons, who has had considerable to do with the operation of refrigerating machinery. In this connection, he realized the lack of knowledge that a great many operating engineers have in regard to indicator diagrams and the compressor, and hence the following paper was written chiefly for their benefit. The paper follows:

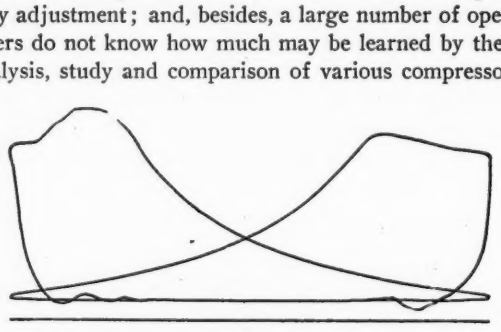
"Of no class of machinery is harder service required, nor is any subjected to a more severe test than the machinery of a cold storage or an ice making plant.

"Too much care cannot be exercised in the construction of such machinery; and the user who buys inferior machinery, because it is cheap, pursues a 'penny wise and pound foolish' policy. The efficiency of the best machinery, however, is often seriously impaired in a comparatively short time, after it is put in use, by the incompetency, carelessness or neglect of engineers in charge of its operation.

"There is no better means of ascertaining whether the various parts of a compressor are performing their various functions properly, than by the use of an indicator, such as is used for steam engines. And yet, we find a large number of compressors with no connections or rigging provided for attaching an indicator. At a still larger number of plants we find no indicators. There are some places, however, where indicator, connections and rigging are all provided, and yet the operating engineer never uses them. But, most remarkable of all, the majority of chief engineers who operate refrigerating machines not only do not indicate their own compressors, but resent the suggestion that someone else do it for them. It must be admitted, however, that the application of an indicator to a compressor often puts an engineer to considerable inconvenience, where the necessary attachments are not at hand and prepared for easy adjustment; and, besides, a large number of operating engineers do not know how much may be learned by the careful analysis, study and comparison of various compressor diagrams; nor do they realize that all the conditions of operating must be taken into account, if the object is to detect and locate defects in the internal parts of a compressor, by means of such diagrams.



No. 1



No. 2

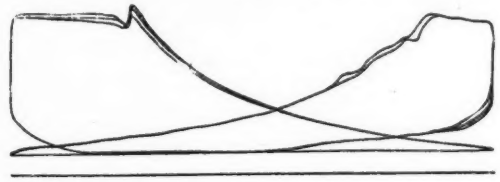
"It requires intelligence, forethought, much preparation and eternal vigilance to keep a refrigerating or an ice making plant up to its maximum capacity and highest efficiency during a continuous run, every week, every day and every hour, for a period of four or five months.

"To put a plant in condition, in winter or spring, to insure the best results during the warm season, is like preparing for a battle. Not the slightest thing that can affect the operation of the plant should be neglected. As soon as the machinery and apparatus have been put together, after the winter's overhauling and repairs, every part of the plant should be thoroughly tested before the advent of warm weather. You cannot be sure that your joints are all tight unless you test them under pressure. Neither can you be sure that your compressors are in the best possible working order unless the pistons, valves, valve springs, etc., are properly tested.

"For instance, every part of a compressor may be in perfect operating condition, but indicator diagrams taken from it under various condensing pressures, back pressures, speeds and adjustments of the means of cooling the cylinder, will vary in appearance, according to the conditions. These variations often render the diagrams not only worthless, but often harmfully misleading, to one who depends on only a casual inspection of the diagram, in trying to determine whether the compressor is giving the best possible results. But, if these diagrams, taken under varying conditions, are properly studied and compared, much valuable information can be derived from them, and the conditions that are conducive to the best results can be determined.

"The indicator can be made to play an important part in determining the relative merits of the various types and designs of ammonia compressors and of the several methods in practical use, for cooling the compressor cylinders. It is my present purpose, however, to confine myself to trying to interest every one connected with the every-day practical operation of refrigerating machinery in the advantages that may be derived from the intelligent and frequent use of the indicator and its diagram in connection with ammonia compressors.

"With compressors of different types and designs there are more or less parts that are subject to derangement and which require proper adjustment from time to time. The piston or any one of the valves may leak, or the valve springs may not be properly adjusted, or the means for cooling the compressor cylinder may not be properly regulated. Any one of these defects can seriously impair the efficiency of the compressor. It is therefore the duty of the operating engineer to use every means available to detect such defects. A great many engineers seem to think that so long as their machines can be made to do the work required of them, the compressors must be all right. But, in many cases, refrigerating machines are run at a much higher speed than necessary to do the work required, on account of the impaired efficiency of the compressors, and the coal consumption and the wear and tear of the machine are correspondingly increased. Where no regular record of the revolutions of the machine is kept, no comparisons can be made with the original speed, and that the speed is being gradually increased will not be noticed.



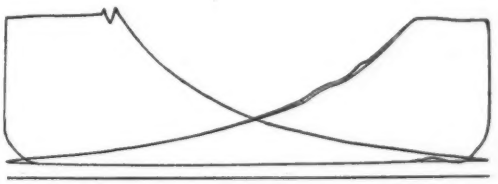
No. 3

"The accompanying diagrams show some of the things that may be learned from indicating compressors:

"Sets No. 1 and No. 2 were taken from a horizontal double-acting compressor, which was provided with a water jacket. The engineer, however, was in favor of the wet compression system, and made no use of the water jacket. He protested strongly that his compressor was all right, and that he did not want any indicator cards from it. He was induced, however, to make preparations for attaching an indicator, and was told to operate the compressor and regulate the cooling of the cylinder as he thought best. The set of diagrams No. 1 was then taken. You can imagine the engineer's surprise when he was shown, by this means, that the discharge valve at head end required a great excess of pressure to open it, that it did not then open wide enough, and that it did not close promptly. It was also demonstrated that he was admitting too much liquid ammonia to his compressor. Set No. 2 was taken some time later, after the freezing back had been reduced until the discharge became hot.

"The loss due to clearance, which was about 17 per cent. when No. 1 was taken, was reduced to about 10 per cent. when No. 2 was secured. It was also discovered by means of the indicator that the high-pressure ammonia gauge was indicating about 25 degrees higher than the actual pressure. In consequence of an apparently too high condensing pressure, the chief engineer was spending a large sum for additional condensors, in order to reduce the pressure. It would have cost less to have had his gauge tested. Diagrams No. 3 and No. 4 were taken from a double-acting vertical compressor, which was being used for ice making. When No. 3 was taken there was so much liquid ammonia entering cylinder that the discharge was quite cold.

"The engineer said he considered it proper to circulate as much liquid ammonia as possible. He confided the fact, however, that he did not freeze back quite as hard as his predecessor did. No. 4 was taken after the freezing back had been reduced till the discharge was hot. This convinced the engineer that the refrigerating work done was not always in direct proportion to the intensity of the freezing back. These diagrams showed also that one of the suction valves was leaking badly.



No. 4

"For the benefit of all concerned I would strongly advise that the manufacturers of ammonia compressors should furnish every connection, attachment and convenience that are necessary for the easy and quick adjustment of an indicator to their compressors.

"I would urge every engineer operating ammonia compressors, to take indicator diagrams from his compressors before shutting down for the winter overhauling and repairs, and also as soon as the machines are in operation again—before the advent of the summer season. Then diagrams should be secured at several times while the compressors are working under their summer loads.

"An engineer, in order to understand the value of such diagrams, however, must be able to properly read and understand them. Diagrams from ammonia compressors are much more difficult to read than those from a steam engine, but the engineer who studies to become expert in interpreting them will find himself well repaid for his trouble.

"Before closing, I wish to say most emphatically that I would not have any one draw the inference, from the foregoing, that ammonia compressors, in general, are subject to frequent derangements. I would simply call attention to the importance of adopting the best possible means for detecting any defects or derangements that might occur."

———o———

Modern practice in the use of alternating current imposes conditions that require generators of radically different characteristics from the older types designed primarily for lighting purposes. The use of induction motors, arc lamps and other devices tending to introduce inductive conditions into an alternating current system has necessitated the use of generating apparatus that will have good regulation and produce normal voltage at all power factors incident to these inductive conditions.

THE COMBINATION OF INDICATOR CARDS

The Value of Combining Indicator Cards as Seen from a Designer's Point of View

By Chas. S. Linch.

In the design of multiple cylinder engines, the first step is to determine what is known as the referred mean effective pressure. This is the mean effective pressure that is required to perform the whole amount of work if the same was to be obtained from the low-pressure cylinder alone. This mean effective pressure must be multiplied by a factor (since no engine is a perfect engine) and the back pressure deducted, after which the true mean effective pressure is obtained. For instance, assume that the boiler pressure is 160 pounds gauge or 175 pounds absolute and assume a back pressure of 4 pounds absolute and a vacuum of 26 inches. Assume, also, that the

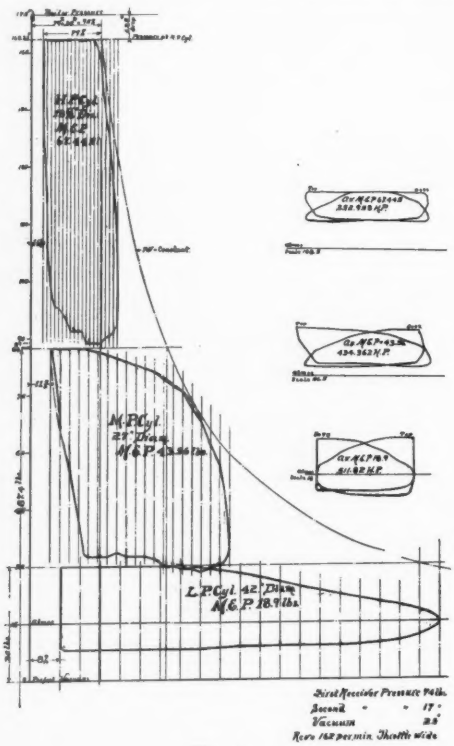


Fig. 1

size of the cylinders for a compound engine having a ratio of cylinder capacity 1 to 4 is required, steam cutting off at 50 per cent. of the stroke in the high-pressure cylinder when delivering maximum power.

The total ratio of expansion would be $.5 = 4 \div X$, or, $x = 8$; that is, the total rate of expansion with cylinder ratios as above would be 8, and to develop the same power in a single cylinder engine we would require a cut-off of one-eighth, or 0.125 of the stroke. The mean effective pressure can then be obtained by the formula $174 \times (1 + \text{hyperbolic log } R) \div R$. R in this case $= 8$ and the hyperbolic log of 8 is 2.0794, so that the formula becomes $175 \times (1 + 2.0794) \div 8 = 175 \times 0.3849 =$ 67.35 pounds. Subtracting 4 pounds for the back pressure, the mean effective pressure becomes 63.35 pounds.

Now this pressure is that which would be obtained with a perfect engine, hence it will have to be multiplied by a factor which is known as the designing factor. This factor is a ratio and is obtained by dividing the actual referred mean effective pressure by the theoretical mean effective pressure. Assume this ratio as 58 per cent. and we obtain for the correct mean effective pressure $63.35 \times .58 = 36.74$ pounds, from which by the proper use of the horse power formula, the area of the low pressure can be obtained and dividing that area by 4, the cylinder ratio, the area of the high-pressure cylinder is obtained.

The combination of indicator cards gives on an enlarged scale the variation of pressures and volumes and shows the defects more distinctly than the ordinary card and shows very clearly wherein the real cards differ from the theoretical combination. A description of the method of combining cards is therefore given, as well as the computations necessary. Let it be assumed that cards have been taken from the three cylinders of a triple expansion engine, 18, 27 and 42 inches in diameter, 24-inch stroke. The clearance in the high-pressure cylinder is 16 per cent. of piston displacement, the clearance of the intermediate is 11 per cent. and that of the low-pressure cylinder 8 per cent. The ratio of low-pressure cylinder to high-pressure is therefore 5.09 and the ratio of low-pressure to intermediate is 2.41. Assume the length of the high-pressure card to be 2" = volume of the high-pressure cylinder.

Now erect a vertical line which is the pressure line on the scale of say 10 pounds = one inch. Set off on this line the pressures from perfect vacuum. Draw the horizontal line through the zero point for the line of perfect vacuum and 15 pounds from this line draw another horizontal line representing the atmospheric line. Take the actual high-pressure indicator card and divide it into 20 equal parts and erect vertical lines and measure the pressures at the points both for the out and return strokes. On the enlarged diagram, set out the clearance line parallel with the pressure line. As we have selected 2" for the length of the high-pressure card and as the clearance is 16 per cent., this line will be $0.16 \times 2 = .32$" from the pressure line. Now divide the 2" into 20 equal parts and set off the pressures to the new scale and the lines drawn through these points give the enlarged high-pressure card. Having completed the high-pressure diagram, the intermediate cylinder card should next be plotted if the engine is a triple or the low-pressure if the engine is compound, remembering always to plot pressures and volumes to the same scale as selected for the high-pressure card.

Since in the above case the engine has three cylinders, we next take the intermediate card and treat it precisely the same way and plot on the new drawing. The ratio of cylinders being 2.41 and the high-pressure card having been made 2 inches in length, we have $2.41 \times 2 = 4.82$" for the length of the intermediate card, and as the clearance is 11 per cent., we have $0.11 \times 4.82 = 0.52$" as the length of clearance, or $4.82 + 0.52 = 5.34$ as the length of the card. The intermediate card

having been laid down, the low-pressure card is treated exactly in the same manner.

The cards are now placed in their proper positions and the various defects of the engine are presented to the eye. It can also be seen how close the real cards approach the ideal condition and the ratio of real conditions to the ideal or the designing factor can thus be obtained.

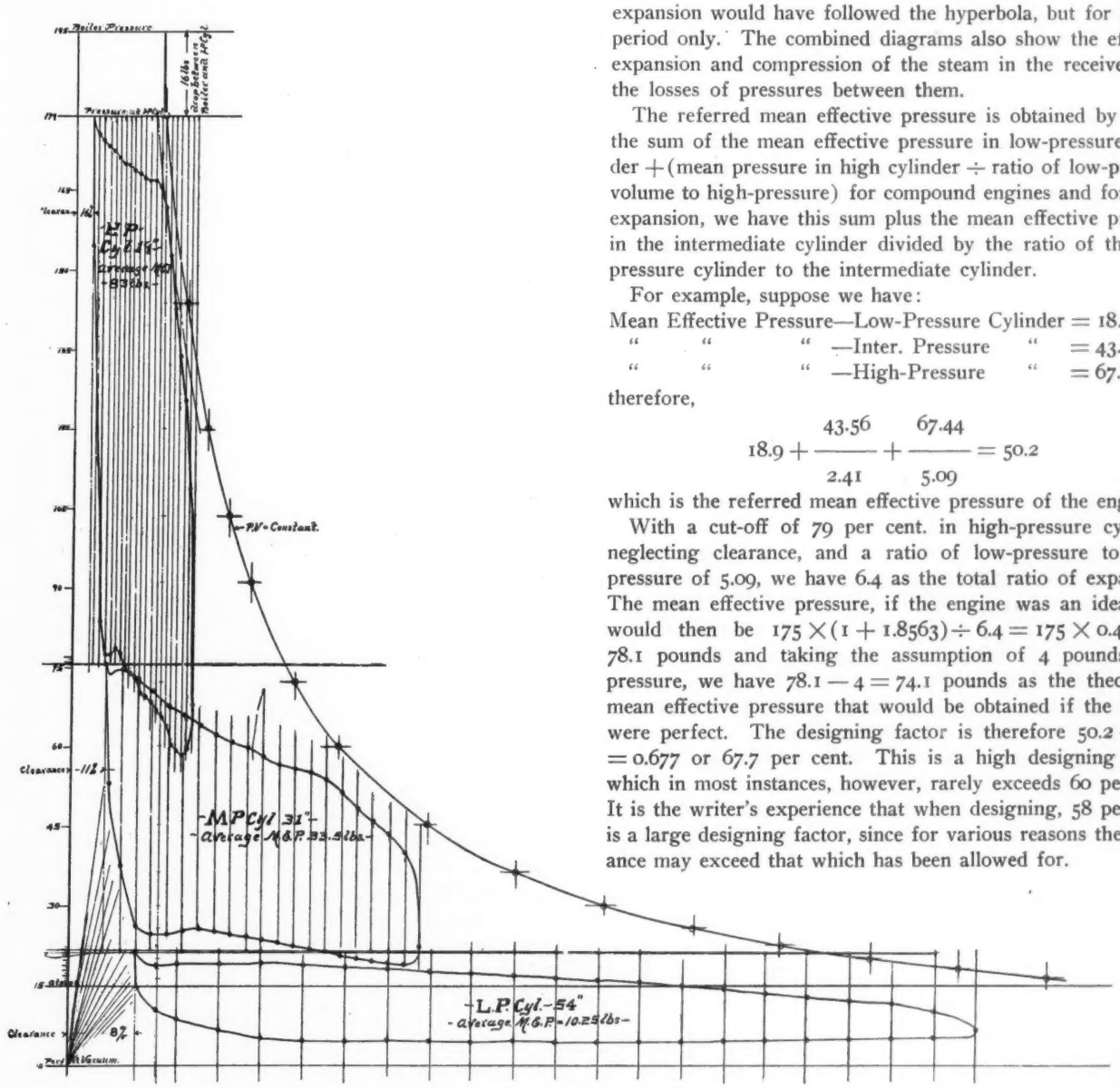


Fig. 2

Assuming, now, that the steam expands according to Boyle's law, that is $pv = c$, plot the curve. This curve is now plotted not with the apparent ratio of expansion but with the actual ratio because the clearance is known. Having drawn the $pv = c$ curve, we find a great discrepancy between the computed and actual mean effective pressures. This ratio, as mentioned, is the designing factor.

When new engines are designed and the sizes of the cylinders are determined, the clearances are not definitely known, so that a designing factor of some successful engines are taken which will be near what is required. In the accompanying illustration, where three cards from a triple expansion engine have been combined, it will be observed that there is a drop of 6.25 pounds from boiler to high-pressure cylinder and that just before cut-off there is a slight wire-drawing, but the admission line is very good. It will be further noticed that if the wire-drawing effect was eliminated, the first part of the expansion would have followed the hyperbola, but for a short period only. The combined diagrams also show the effect of expansion and compression of the steam in the receivers and the losses of pressures between them.

The referred mean effective pressure is obtained by taking the sum of the mean effective pressure in low-pressure cylinder + (mean pressure in high cylinder ÷ ratio of low-pressure volume to high-pressure) for compound engines and for triple expansion, we have this sum plus the mean effective pressure in the intermediate cylinder divided by the ratio of the low-pressure cylinder to the intermediate cylinder.

For example, suppose we have:

Mean Effective Pressure—Low-Pressure Cylinder = 18.9 lbs.
" " " —Inter. Pressure " = 43.56 "
" " " —High-Pressure " = 67.44 "

therefore,

$$18.9 + \frac{43.56}{2.41} + \frac{67.44}{5.09} = 50.2$$

which is the referred mean effective pressure of the engine.

With a cut-off of 79 per cent. in high-pressure cylinder, neglecting clearance, and a ratio of low-pressure to high-pressure of 5.09, we have 6.4 as the total ratio of expansion. The mean effective pressure, if the engine was an ideal one, would then be $175 \times (1 + 1.8563) \div 6.4 = 175 \times 0.4463 = 78.1$ pounds and taking the assumption of 4 pounds back pressure, we have $78.1 - 4 = 74.1$ pounds as the theoretical mean effective pressure that would be obtained if the engine were perfect. The designing factor is therefore $50.2 \div 74.1 = 0.677$ or 67.7 per cent. This is a high designing factor which in most instances, however, rarely exceeds 60 per cent. It is the writer's experience that when designing, 58 per cent. is a large designing factor, since for various reasons the clearance may exceed that which has been allowed for.

We now have data in our possession which is of value, not only to the designer but to the running engineer who should whenever he gets cards combine them and keep them for future reference, as they will be of great use in deciding important qustions which continually arise.

The accompanying illustrations represent the combination of indicator diagrams from two vertical fore-and-aft triple expansion condensing engines. Fig. 1 represents the combination of cards taken from an 18, 27 and 42 by 24 inch engine. The initial pressure was 175 pounds absolute, the pressure in

the receivers being 74 and 17 pounds gauge pressure respectively, and the vacuum 25 inches. As the cards combine very well, it is found that this engine has a designing factor of 67.3 per cent.

Fig. 2 represents the combination of cards from a larger engine having cylinders 19, 31 and 54 inches in diameter with a 42-inch stroke. In this case the initial boiler pressure was 195 pounds absolute, the receiver pressures being 60 and 5.5 pounds gauge respectively. As will be noticed, the cards do not combine so well as those shown in Fig. 1, and consequently the designing factor is only 59.5 per cent.

COMPRESSION IN A STEAM CYLINDER

By W. H. Wakeman

It is not practical to give a cast-iron rule for the best compression pressure in all cases, for what is right for some conditions, is wrong for others. It is safe to say that, as a general rule, one-half of boiler pressure is right for medium and slow speeds, which may be increased to full boiler pressure for high speeds. The above refers to non-condensing engines.

Of course, a condensing engine needs compression the same as if it exhausted into the air, but it is not practical to give it. Suppose that Fig. 1 represents a condensing engine, with an absolute pressure of 3 pounds in front of the piston, which is 12 inches from the cylinder head. When it has advanced to 6 inches, it is 6 pounds, at 3 it is 12, while at 1.5 inches there

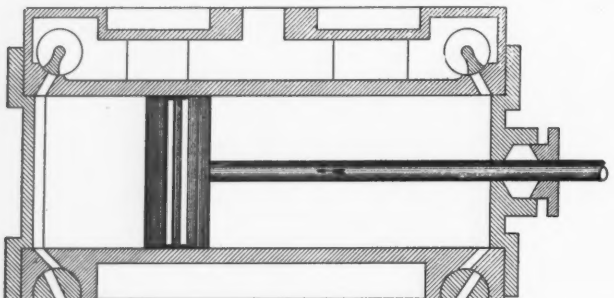


Fig. 1

are only 24 pounds, or 9 pounds above the atmosphere to bring the heavy parts to rest.

There are few cases in which this is enough to give good results. The only way to get more is to close the exhaust valve earlier in the stroke, but this is not desirable, because it cuts off communication between the cylinder and the condenser, hence the beneficial effect of a good vacuum is lost during much of the return stroke.

A few days ago I examined a modern Corliss engine just erected to supply power for an up-to-date plant. The cylinder was 20 x 36 inches, speed 120 revolutions per minute. Suppose that Fig. 1 represents this cylinder. The condenser is shut off from the cylinder in this case at one-third stroke, to secure compression to equal one-fifth of the steam chest pressure. If we set the exhaust valve to close when the piston is 18 inches from the cylinder head, and follow out the same theory as before, the compression will be 48 pounds absolute when the above distance is reduced to 1⅛ inches.

This is impractical because the cylinder would be cut off from the condenser at one-half stroke, which means much loss of efficiency.

In the case of a simple condensing engine, the exhaust valve may be left open until the stroke is nearly completed, which overcomes the above objection, then by giving the steam valve more lead the moving parts are cushioned. This requires very careful adjustment in order to prevent steam from blowing through into the exhaust chest as before explained.

This is not practical in the case of the low-pressure cylinder of a cross-compound engine unless the receiver pressure is high. In many cases it does not exceed atmospheric pressure, therefore it is not enough to provide the necessary cushion. In such a case the exhaust valve would probably have to be closed when about three-quarters of the return stroke is completed, and enough lead given to secure a quiet running engine.

One advantage of the tandem compound engine is that all necessary compression can be secured in the high-pressure cylinder without detriment to any other operation, and this leaves the engineer free to adjust the exhaust valves on the low-pressure cylinder so as to secure best results from the condenser.

As I have cited one case where compression was beneficial and another in which it was of little value, it leaves the weight of opinion about balanced so far as they are concerned, but the following incidents show that compression is practically indispensable, in some cases at least:

A certain engineer in charge of a 20-inch Harris-Corliss engine, fitted with the crab claw releasing gear, found that ordinary engine oil would not keep his crank pin cool. He tried a better brand without much improvement, which caused him to try cylinder oil that gave temporary relief, but frequent applications of water were still found necessary, and it was seldom possible to run for five hours continuously. Castor oil was then used and gave better results for a time, after which white lead was applied, but still the pin became hot every day, resulting in trouble for the engineer and loss to his employers.

New crank pin boxes were then made and very carefully fitted to the pin. They proved no better than the old ones, even after being used long enough to secure a perfect fit. The old crank pin was then taken out and a new one put in, without removing the cause of trouble and expense.

Much worry and hard work for long and weary days extending far into the night compelled the engineer to take a short vacation, while a substitute took charge of the plant. It was not a desirable condition of affairs to leave, but there was no help for it. The substitute secured permission of the regular engineer to make any desired changes, as otherwise he would not meddle with any adjustments on a plant that he was only hired to run for a few days. Right here I wish to say that any other course would have proved the substitute dishonorable, and unworthy of confidence in the future, for when

a man is employed for a short time under ordinary conditions he should run the plant the required time, then leave it just as he found it.

As it was necessary to keep the engine in motion during the day, except when shut down to cool the crank pin, all experiments had to be made at night.

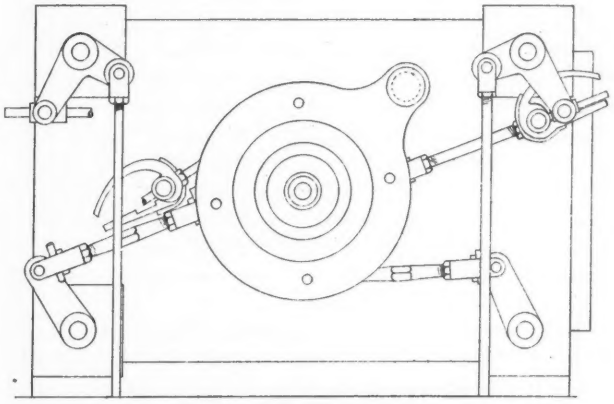


Fig. 2

Several years previous to this time I was engineer of this plant, hence the substitute asked me to assist him in making changes and it is not necessary to say that I readily agreed. Much valuable experience has been gained by the writer in this way and while assisting others.

Now, the substitute concluded that there was nothing the matter with the crank pin, or its boxes, but that the cause of trouble was located at the opposite end of the machine, in the exhaust valves; or in other words, they were not adjusted to give enough compression.

In order to prove the truth of this idea we erected a reducing motion and took some diagrams. They showed a sharp turn at both lower corners, thus proving that there was no compression whatever. We lengthened the right and left con-

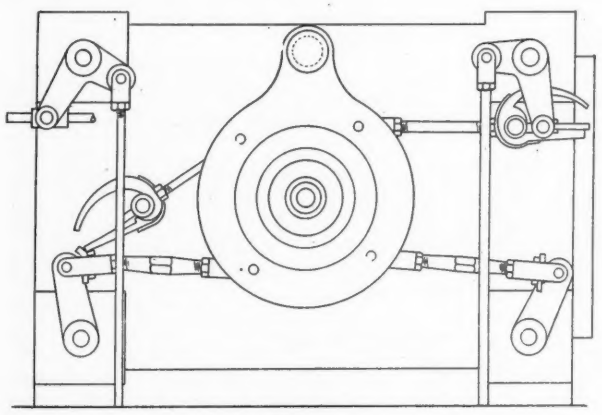


Fig. 3

nections between the wrist plate and the cranks on the exhaust valve stems, until compression pressure equalled about one-half the initial pressure by the gauge. See the lower connections in Fig. 2.

The result was that no more time was lost in shutting down to cool off that crank pin, and as the rough surface caused by previous heating gradually disappeared, the pin assumed normal conditions, and another victory for compression was scored.

In conclusion, I will relate an incident (or accident) that occurred about 9 o'clock in the evening, while running this engine to prove the valve adjustments.

Without apparent cause the crab claw stem broke in two, as illustrated in Fig. 2, allowing the crab claw to drop down on the exhaust valve connection. The wrist plate is now in its extreme position to the right, and is about to change its direction of travel. Fig. 3 illustrates the result after it has reached a vertical position. The right and left exhaust valve connection is badly bent, also the key, its cotter and the strap holding the small boxes in place.

On viewing the "wreck" after steam had been shut off, and the engine brought to a stop, we were sadly dismayed, as it was then late in the evening and the machinery had to be started at 7 o'clock the next morning. The fact that neither of us was in our own plant increased our disgust. Examination of the broken crab claw showed that the accident was due to a bad flaw.

That engine started on time the next morning, with repairs so well made that nobody knew of the trouble until we told them, at our convenience.

Boiler Explosion at Taylor, Pa.

One of the four boilers in the plant of the Taylor Worsted Company, at Taylor, Pa., exploded on Saturday afternoon, January 6th, killing the engineer outright and badly injuring the fireman. The boiler was of the horizontal return tubular type, 60 inches diameter and 12 feet long. An examination of the boiler revealed that it had rent along the seam, which had been a double riveted lap joint. Both heads were partly torn out and bent over, pulling clear out from the tubes, some of which were also bent over and twisted out of shape. The engine in the engine room was also pretty well smashed up, the rim of the fly-wheel, while remaining unbroken, was snapped off from the spokes and hung loosely about the shaft.

The explosion occurred on Saturday afternoon, just a few minutes after shutting down, and the 200 or more employees, who were standing before the office waiting for their pay envelopes, were alarmed by the explosion which sent the exploded boiler through the side of the mill, throwing timbers and bricks through a large portion of the factory. Three men who were in the boiler house were sent hurling through the air, the engineer, Patrick Connerton, being killed and John Gallagher, the fireman, being badly injured, the third man escaping with slight injuries. With the crash of the boiler, which also tore the three other boilers from their beds, a panic among the employees ensued, as it was thought that many persons were caught in the ruins. The explosion is thought to have been due to the running of cold water into a dry and overheated boiler.

A polyphase induction motor may be started from rest by direct connection to the supplying circuits, but in so doing the motor draws from the line a current considerably in excess of the normal full load current, and if the motor be of large capacity, this excess current may disturb other apparatus on the system, so that starting devices for this reason will often have to be used.

The
Practical Engineer

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L. L. RICE

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The total circulation of The Practical Engineer for the year 1903 was 77,250 copies, an average of 6437 copies per issue. The total circulation for the year 1904 was 132,000 copies, an average of 11,000 copies per issue. The total circulation for 1905 was 182,500 copies, an average of 15,208 copies per issue.

Any Advertiser is invited to examine our Paid Subscription Lists and Post Office Mailing Receipts at any time.

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CONTENTS

PAGE.

A Typical American Village Central Station..... 3
Device for Engine Room Telephones..... 4
Auxiliary Power and Heating Equipment—Atkinson..... 5
Methods of Keeping Power Plant Records..... 7
The Practical Value of Indicating the Ammonia Compressor 12
The Combination of Indicator Cards—Linch..... 14
Compression in a Steam Cylinder—Wakeman..... 16
Boiler Explosion at Taylor, Pa..... 17
Editorial:
How Engineers Value Advertising..... 18
Letters from Engineers:
Banking Fires 20
Setting Wolf Valve Gears..... 20
Babbitting Eccentric Straps 20
Why Does an Injector Force Water into a Boiler?..... 21
A New Method for Piping up Indicator which Should be Avoided 21
Do It Now! 22
Putting in a Fire-Room Floor..... 22
Give the Fireman a Chance..... 23
Easy if You Know How..... 23
Methods of Laying Down and Figuring Compound Cards 23
Questions and Answers.....24- 28
Jenkins Bros. Extra Heavy Valves..... 28
Goetze's Elastic Profiled Copper and Asbestos Gaskets.... 29
American Boiler Flue Cleaner..... 29
Book Reviews 30
Trade Notes 32- 34

How Engineers Value Advertisements.

In the last issue of THE PRACTICAL ENGINEER, we published a letter from a Mr. Campbell, in which he asked us to cut him off the list because he objected to the advertisements. In this connection we printed a few remarks about the subject of advertisements and their relation to the average engineer.

It must be remembered that stationary engineering is a business which involves two kinds of knowledge: technical and commercial. It is just as important for an engineer to be acquainted with the various types of engines and boilers, brands of packing and the kinds of feed-water heaters, separators, valves, lubricators, etc., as it is to have a complete knowledge of the laws of thermodynamics, hydraulics, mechanics of machinery, electricity, chemistry and the other allied sciences. The two must inevitably work together and the successful stationary engineer of today is the one that mixes this knowledge in the proper proportions.

That many of our readers appreciate the value of the combination of practice and theory is shown by the hundreds of letters which we have received during the past month and it is gratifying to note that without exception all the writers of them say that they appreciate the value of reading the advertisement columns as well as the reading columns. Unfortunately, however, space will only permit us to publish a few of these letters but the sentiment expressed in these is a fair sample of the sentiment expressed in all which we have received.

Mr. W. H. Wakeman says:

EDITOR THE PRACTICAL ENGINEER:

I have noted your editorial in the January issue concerning the value of advertisements in your paper and in this connection will say that in my opinion an engineer cannot keep abreast of the times unless he pay attention to this department. I have gained much information from these advertisements, also from catalogues sent out by these advertisers, who pay for them, as the subscribers to a mechanical paper do not pay for the advertisements.

I frequently obtain enough information from one issue of your paper to more than repay the cost of twelve issues and have never seen a copy that was not worth more than it cost. I hope you will have many more advertisements during the year 1906.

New Haven, Conn. W. H. WAKEMAN.

Mr. Peter Hardman says:

EDITOR THE PRACTICAL ENGINEER:

In looking over the issue of THE PRACTICAL ENGINEER for January, I was sorry to read of the excuse that Mr. Campbell gave in discontinuing the paper, namely: the advertising matter. Giving my experience in reference to same, which I am sure is the sentiment of my brother engineers, I will say that the ads. are as necessary as the reading matter and in particular cases more important. The information and benefits derived from them are an education in themselves. Where is the engineer who has not at some time asked for a catalogue or a book that is advertised free? Who has not been assisted in his work by many of them in the shape of useful information and diagrams of machinery which he has in charge? That information often cannot be obtained in higher priced books and I therefore consider the paper more valuable for its advertisements.

Phila., Pa. PETER HARDMAN.

Mr. A. R. Von Normann says:

EDITOR THE PRACTICAL ENGINEER:

I am obliged to write these lines in order to cool off my indignation about Mr. Norman Campbell's letter, which I saw in your January issue.

It is not quite four years since I was a stationary engineer in a small preserve factory and one who had to shovel his own coal. At present, I am a draftsman with the Westinghouse Electric and Mfg. Co., and my work includes both mechanical and electrical designing.

What I wish to state is that I *blame* my success to the faithful reading and alphabetically indexing of everything of an engineering nature in the technical papers I receive and by also carefully reading the advertisements. Many a good point I have gained through your paper.

When I was indexing your November issue, I found that it covered 48 different subjects of vital interest in the reading columns and each subject of an up-to-date nature. Surely a large amount for little money!

So far as Mr. Campbell is concerned, I feel very sorry for him and I

think he should brace up and strengthen his very weakest point or else "Go back to the woods."

Before closing this letter, I wish to say that I think you and your contributors are doing grand work along educational lines accessible to all who care to know. Wishing THE PRACTICAL ENGINEER continued success, I remain an appreciative and progressive reader.

Turtle Creek, Pa. A. R. VON NORMANN.

Mr. Chas. J. Mason says:

EDITOR THE PRACTICAL ENGINEER:

I have read your leading editorial in the January issue, entitled: "Why Mr. Campbell failed to renew his subscription," with considerable interest. If your statements—particularly those relative to the value of reading advertisements—required any seconding, I would not hesitate to do so; but they do not require any support at all, because the truth of what you say has been established for quite a while.

Commercial engineering—that which is represented in advertisements and manufacturers' catalogues—is slightly different from what I might call academic engineering. Of course, the former is closely related to the latter and it is an outgrowth from it. But while the latter treats of and deals with abstract principles and elements, the former applies those principles and elements to concrete problems of the day. I do not for one moment desire to detract from or belittle the value of theoretical engineering which has played such an important part in the development of the industries of the world; but, for the everyday, practical operating engineer, for whom your paper is published, I have no hesitation in saying that if a choice must be made between the two, commercial engineering should be the one, because it is more closely related to the craft than the other; therefore it is of the greatest importance for engineers to always read the advertisements and to further search for new ones.

As a matter of fact, a library of catalogues is of more value in the power plant than would be one which contained works of a purely theoretical character which treat of abstract principles. A man would very soon become a poor engineer who would not supplement his reading of standard works and text-books by the study of what is contained in the various engineering magazines which are so generously provided for him at so small a cost. Men of high ability and professional standing recognize the value of technical journals, of which advertisements form no small part.

Happy is the man who can equip himself with theoretical knowledge and who will follow it up *constantly* with what is to be learned from commercial engineering.

Scranton, Pa. CHAS. J. MASON.

Mr. J. H. K., of St. Louis, Mo., says:

EDITOR THE PRACTICAL ENGINEER:

Noticing Mr. Campbell's letter in your last issue, I will say that I think he is doing a very foolish thing. I owe my present position of $1000 a year to reading the advertisements in your valuable paper. I have been for a long time one of your subscribers and I will without doubt continue.

St. Louis, Mo. J. H. K.

Mr. R. T. Strohm says:

EDITOR THE PRACTICAL ENGINEER:

That fellow, Mr. Campbell, must be a lunkhead. I'd no more think of slighting the ads. than of neglecting the reading pages. The ads. keep a man up-to-date on devices and equipment.

Scranton, Pa. R. T. STROHM.

Mr. H. J. Johnson says:

EDITOR THE PRACTICAL ENGINEER:

Have read with interest your editorial: "Why Mr. Campbell failed to renew his subscription," and will state how I find myself regarding the matter.

Upon receiving my paper, I usually find myself glancing over the advertisements first thing and then the reading matter, which is highly interesting and from which food for a great deal of thought and study can be found, after which I find myself back to the advertisements again.

I would also like to say a few words regarding the information which may be obtained from the catalogues sent out by the advertisers. These books or pamphlets are often instructive and are usually gladly sent out free for the asking by the advertisers who are anxious that engineers should at least become familiar with their products and engineers will find that this knowledge will not come amiss.

Finally, I think Mr. Campbell has paid THE PRACTICAL ENGINEER something of a compliment, as a large amount of advertisements is one of the infallible indications that it is a good mechanical paper and that it is reaching good and appreciative readers.

White, S. Dakota. H. J. JOHNSON.

Mr. T. J. O'Donnell says:

EDITOR THE PRACTICAL ENGINEER:

The communication from your subscription department, in reference to the renewal of my subscription, received and I hasten to comply, as I do not wish to miss a single copy of THE PRACTICAL ENGINEER, because I think it is one of the best papers published, both for the college graduate or the man whose knowledge of the steam engine is limited to his years of experience. I take great pleasure in reading the ads. and find that much useful information can be gained from them. I thank you again for calling attention to the fact that my subscription expired.

West Phila., Pa. T. J. O'DONNELL.

Mr. Rolfe says:

EDITOR THE PRACTICAL ENGINEER:

I could not help but notice why Mr. Campbell failed to renew subscription in the January issue and the difference between his case and mine. I will tell you mine. I was on the St. Lawrence River last year and I wanted some firebrick badly. I have three technical papers besides THE PRACTICAL ENGINEER. I looked them over but could not find anything in the firebrick line. I did not want to slight THE PRACTICAL ENGINEER, so I looked over it and found the ad. of Cyrus Borgner, of Philadelphia. I sent for 300 bricks and they were first-class. I think advertisements in a journal like THE PRACTICAL ENGINEER are very essential to the engineer.

Gouldsboro, Maine. ARCHIE C. ROLFE.

Mr. Savage says:

EDITOR THE PRACTICAL ENGINEER:

I note in your issue for January, a copy of Mr. Campbell's letter in which he requests that his subscription be discontinued on the ground that he does not wish to pay for the advertisements. I would state that I am not surprised that some engineers would write such a letter so long as "political licenses" are issued in such cities as Detroit. If you have got a "pull," a license is easy to obtain, but if not, you must stand an examination that would make a United States civil service examination look diminutive in comparison. Regarding the advertisement matter in your paper, I consider it as interesting and essential as any part of the paper, especially if one is holding down a steady job. It is the best way to keep in touch with the latest inventions when an engineer has no opportunity to get out and see "the latest" personally.

I am a middle-aged man and have operated plants from boyhood, but I have yet to read an issue of THE PRACTICAL ENGINEER which fails to impart to me knowledge worth its weight in ——— well, *Silver*, at least.

Detroit, Mich. B. C. SAVAGE.

Mr. Gingrich says:

EDITOR THE PRACTICAL ENGINEER:

I differ in some respects from Mr. Mr. Campbell. I like to see what people with brains and ingenuity are doing. I think there is nothing equal to THE PRACTICAL ENGINEER for the price or several times the price.

Chicago, Ill. E. A. GINGRICH.

In conclusion, it may be said that an engineer should always be in a position to decide what is required in a power plant. If he is not able to do this, then he must either call in a consulting engineer to study the requirements of the plant or else he must call upon the representatives of the different classes of apparatus to tell him what he needs. The engineer himself, however, is the best person to give his unbiased judgment as to the requirements of the plant and to do this properly he, of course, must know what goods are on the market.

The World's Oil Output.

The United States supplied more than one-half of the petroleum produced in the world in 1904. A statement of the world's production of petroleum, prepared by the British Board of Trade, puts the petroleum production for 1904 at 9,303,000,000 gallons, of which 4,916,000,000 gallons were produced in the United States, 3,650,000,000 gallons in Russia, 202,500,000 gallons in Austria, 206,500,000 gallons in Java and Sumatra, 135,000,000 gallons in Roumania, 105,500,000 gallons in British India, and 49,000,000 in Japan. The world production of 1904 breaks all records, the year 1903 having previously held the record with 8,504,000,000 gallons produced.

Polyphase Induction Motors.

The polyphase induction motor may be described as a moving static transformer, wherein the energy supplied to the primary is induced in the secondary, producing mechanical energy. The primary windings are so arranged and grouped that when a polyphase alternating current is applied there is produced a rotating magnetic field, the reaction between the currents induced in the secondary and the rotating magnetic field in the primary producing rotation and power.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Banking Fires.

EDITOR THE PRACTICAL ENGINEER:

In the November issue of your very practical journal, you take up the subject of "Banking Fires." There are some points in the article that I wish to take exception to, and one of these is the leaving of the fire door open. There is no doubt but that this will create trouble for the engineer, and lots of it. After a man has spent a few Sundays in a dirty combustion chamber rolling tubes, he will certainly find some different method in his fire banking, for such has been my experience. I tried the method quoted in the article referred to and found that I was always having leaky tubes and I changed to the following method, which has always given me the best results:

Just before shutting down at six o'clock, about five or ten minutes before depending on the load, I push back the good, live coals to one of the back corners of the grate and against the bridge wall, leaving what clinkers and other dirt there are on the grates to be removed in the morning. I then throw in three or four shovels of coal on this bank of fire and let it burn a minute or two. I then throw over this slow burning mass, a small shovel or two of ashes, close the ash-pit and fire-doors tightly and close the damper but leaving it slightly cracked to let the smoke out.

I can leave my boiler room in the evening at six with such a fire with about 85 pounds showing on the gauge and in the morning when I come to work I will have 60 or 65 pounds of steam. I then rake off the entire grate surface excepting the small corner where the fire is, pull my bank over to the clean grates and have a fine fire in two or three minutes. This method has always given me the best of results and I believe the editor himself will say it is the best.

Prescott, Wis. C. D.

Setting Wolf Valve Gears.

EDITOR THE PRACTICAL ENGINEER:

In the December issue, on page 28, I noticed a question on setting Wolf valve gears. If Mr. H. B. M. has not studied this kind of gear thoroughly, he will find it pretty hard to set one. An improperly designed valve gear of this kind will sometimes puzzle the most experienced engineer. One time I went out to set one which was no job at all. All I had to do was to put the engine on dead centre and turn the eccentric in the opposite direction. Then I pulled the reverse lever back and forth, the same as you would reverse it, and noticed the valve stem; if it moved I shifted the eccentric till I found a place where it was stationary, which is in the centre of the block shifted up and down by the eccentric. Then I went to work and divided the lead equally on both ends; the engine was steamed up, tried and worked to perfection.

Another time I went out to set one and it took me almost a day trying to find out how to go at it. The eccentric was keyed to the shaft so you could not do a thing with it. I placed the engine on dead centre, took off the steam chest cover and found that it had $\frac{3}{8}$-inch lead on the crank end and $\frac{1}{8}$-inch lap on the head end and yet it was set right. The engine was supposed to be a 25 horse but it was closer to a 15 than a 25. I thought I would try to divide the lead and notice the results and I did notice them. The engine started to pound so that you could hear it for a mile and put more water out through the exhaust than the pump could pump into the boiler. The engine was set back again and left alone until there was time to fix the valve gear over entirely. A little while after, the job was done and this engine is very much more economical than it ever was.

To set a Wolf gear, try it as follows, and I think you will be satisfied with the results: Put the engine on the dead centre and have a man at the reverse lever and yourself at the eccentric. Now let the man at the reverse lever pull the lever to and fro and notice the valve stem; if it moves, shift the eccentric until you find a place where it becomes stationary by shifting it up or down, as the case may be. Then divide the lead on both ends and try the engine by letting it run slowly just so it passes the dead centre; if it passes the centres you have it set up; if not, give it less lead on the slower side till it passes the centres with equal speed.

Wabasso, Minn. F. J.

Babbitting Eccentric Straps.

EDITOR THE PRACTICAL ENGINEER:

Some time ago I had a hurry job of Babbitting a large eccentric strap that was successful, the details of which may be of some interest to a few of your readers, who like myself, are not post-graduates on all repair kinks. The job had to be completed without interrupting the regular run and a third of a day was the time to do it in. So the first thing to do was to *get ready*—an important factor in any successful scheme where haste is imperative.

All arrangements made, I shut down engine, unbolted eccentric strap, and all around between strap and sheave, fitted a narrow strip of Jenkins '96 packing on both sides, thick enough to make a tight joint, after allowing for liners. Meanwhile, four irons, like those shown in Fig. 1, were heated bright red. The strap off, the hot irons were kept in each piece until the old Babbitt melted. It then became apparent that there was trouble ahead to get Babbitt of ordinary pouring temperature to flow around the long, narrow space, as there was only about $\frac{3}{16}$-inch thickness permissible over the anchor lugs shown at L, Fig. 2. So I cut three grooves in each lug as indicated at G with a $\frac{1}{4}$" x 8" emery wheel. Then one half of the strap was heated at a time while the sheave was warmed up with irons, shown in Fig. 1, on top and sides, the underneath part being heated with a gasoline blow torch.

Sheave and strap being hot, one half the strap was put on, the packing strips inserted and the strap clamped in position with cabinet clamps. In the meantime, the joint made by the packing strips was covered with a soft putty of wheat

dough applied with a putty knife. (Dough is far superior to clay or putty, as the heat causes it to adhere fast.) Some powdered rosin was blown in on each side and when the Babbitt approached a dull red, it was poured in both sides together.

The first half was a perfect fit, but the second developed a flaw. Time being limited, so that repouring was out of the question, I sprinkled some sal-ammoniac and powdered rosin on the naked spot and poured in some Babbitt while the strap was still hot and to my delight it made a perfect fusion with

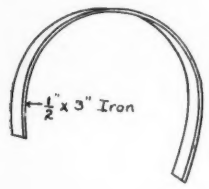


Fig. 1

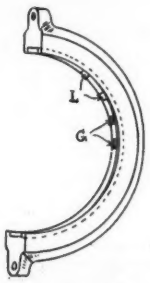


Fig. 2

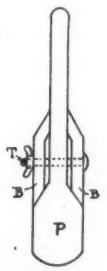


Fig. 3

the original run, it requiring only a bit more scraping than the other half.

After smoothing the Babbitt with a scraper and cutting oil grooves, I next obtained a bearing surface in a short time with the device shown in Fig. 3. This consists of a hard-wood block finished with a half-round nose and handle, the nose being made the same width as the annular ring in eccentric strap. Secured to it are two blocks B, B, held in place by thumb bolt T. In this double clamp I put sandpaper No. ooo at P. My first treatment was with sandpaper alone; next, the same but with powdered graphite added; next, the same with cylinder oil added; next, washed out every particle of grit and other substance with gasoline; next, common, strong, smooth paper was inserted in clamp and the entire surface was polished with powdered graphite and finally the surface was covered with a paste of cylinder oil and graphite. The eccentric strap was then put back on the engine, the engine started up and it has given perfect service to date.

Roanoke, Ala. W. O. Orr.

Why Does an Injector Force Water into a Boiler?

Editor The Practical Engineer:

In reading over the November issue of your paper, I was very much interested in a question asked by J. E. G., as follows: "Why does an injector force water into a boiler?" Now, the editor has seen fit to answer this question, which also agrees with the answer given by one Mr. Hawkins, but I disagree with both and would like to see it opened for discussion. I believe the editor will agree with me when I say there is a vast difference of opinion among the different well-known writers upon the same question.

I agree with the editor that the steam on entering an injector passes through a steam jet which is shaped in good form to increase the original velocity of the steam and that it creates a vacuum in the suction pipe and draws the water into the injector and that the contact of the water with the steam condenses the steam. But I claim right here that when steam is condensed, that it is steam no more. Put it in any form you may, it is condensed and that is the end of it. But I also think that when the steam is condensed it gives the water all its heat units, and that these units of heat so given the water create a large expansion of the water and that the expansion force of the water so given is strong enough to force water into the boiler in great force; and further, the less amount of water given to the injector, the greater the force it will have, for the simple reason that it will receive more units of heat; consequently, it will have greater expansion. I should like to see you publish this and open the question to discussion.

Aberdeen, Wash. V. D. B.

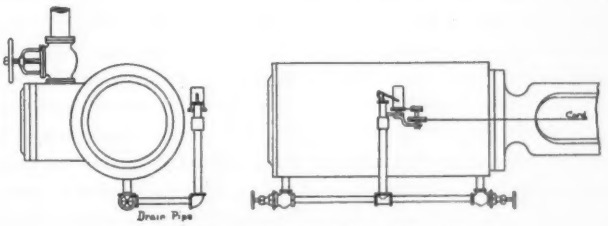
A New Method of Piping up an Indicator which Should be Avoided.

Editor The Practical Engineer:

I herewith enclose a sketch showing how some expert indicator men are piping up cylinders for indicators. I have seen a number of ways of piping up an indicator but the method shown in the sketch is something new to me and I cannot help sending the sketch to you for publication, as it will no doubt interest some engineers and be laughed at by others. This particular piping was done by a man calling himself an expert and who represents a firm that does all kinds of engine repairs.

The writer was called to this place, where this indicator piping was installed, to examine the cylinder and report to the owner if the cylinder really needed to be rebored, as the so-called expert told him that the cylinder was in bad condition and should be rebored at once and new rings put in, as a large part of the steam was going out of the exhaust.

After the writer arrived, he took off the cylinder head and removed the piston and measured the cylinder from one end to the other by a micrometer gauge and found the cylinder out only six-thousanths of an inch (.006"). The ring was in fine condition and had the proper tension; the piston was well in the centre of the cylinder and not a drop of steam escaped through the ring at full steam pressure. I reported this to the owner, after which he told me about this expert indicator man.



Wrong Way of Connecting Indicators

I asked if I could see a card which had been taken, but no card could be had, for the man told the engineer that it was a rule of his firm that no cards should be left with anyone, so I was in the dark as to how the cards looked. From my opinion it would have been about as good to have placed the indicator on the water main as where it was put, for the engine belonged to the common slide valve type, having a throttling governor, and as the long steam pipe was uncovered, a great deal of condensation was formed between the boiler and engine, which showed itself by opening the drips, from which the indicator was piped up.

When I was told that the engine had been indicated a few days before, I could not believe it as there were no holes drilled on the side or top of the cylinder for indicator pipes. They then showed me the arrangement as shown in the illustration.

The man who did this indicating has sprung up to be an expert during the last few months. I have done this kind of work for the past twenty years and I am still willing to take lessons on indicator card reading. So far as indicating an engine goes, anyone can learn in short notice but to understand the correctness of a card is another thing. I have in my possession hundreds of cards taken from simple, compound, and triple expansion engines and it requires a great deal of study to say whether they were taken with correct or incorrect piping and to understand the card, to figure same, to use the proper spring and to find the steam consumption.

A few words to the young engineer who is beginning to learn indicating. Do not pipe your indicator as shown in sketch because you will not have the correct card from your engine, and you will not only ruin your indicator but also your future in the indicating line. Use judgment and take advice from men who have for years been indicating engines. There are lots of men who are well up in testing engines and they will no doubt give you a correct answer if asked anything about an indicator.

Allentown, Pa. JOHN T. LINDSTROM.

Do It Now!

EDITOR THE PRACTICAL ENGINEER:

How many engineers will realize the importance of the motto: "Do it Now!" when applied to steam engineering. You will often notice in traveling and visiting different steam plants that in not a few there will be found some very strong evidence of either careless or incompetent men in charge. Steam will be oozing from nearly every valve stem and steam joint and while you are looking around there is apt to be a profusion of "hot drops" showering from some leaky steam pipe down your collar, which, for the time, will make you sorry you are alive.

Among other things you will often find the engines knocking away like a professional "knocker"; the stuffing boxes of both steam and water end of the pumps leaking away as if they were there for no other purpose; no regular inspection of the boilers is ever made either by insurance inspectors or inspectors appointed where there is a license law; the safety valves are overloaded and the gauges do not register the proper pressure. It is true that all these defects probably do not exist in any one plant for if they did they would drive the average man crazy.

Returning to the heading of this article: if the engineer, upon the discovery of any small leaks or any unusual sounds in his engines or pumps or any other auxiliaries about the plant, will take the necessary tools and "Do it now," or if plant owners and managers would have things "Done now," they would have fewer breakdowns, fewer large repair bills to pay, less fuel consumed, larger dividends for the stockholders and a plant that can be relied upon and which will always be in first-class working condition.

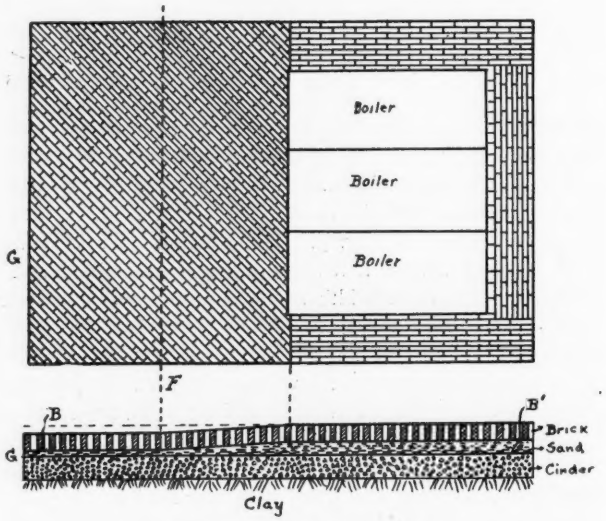
Hang a "Do it now!" card in some conspicuous place, keep a "Do it now!" resolution in your head and watch the results.

Columbus, Ga. Q. E.

Putting in a Fire-Room Floor.

EDITOR THE PRACTICAL ENGINEER:

I happened in on a fellow some time ago that had just taken charge of a new plant. Apparently everything was in readiness to start but the fire-room floor, and for some reason or other the building contractor had not started that, and the owner of the building got sorely vexed and told the contractor to gather up his men and tools and "git." The engineer seemed in a quandary as to just where to begin, and turning to me, asked me how I put the floors in where I am employed? I told him that the first thing to do, provided material, such as brick, sand, cinders and cement were at hand, would be to excavate that portion of the fire-room where the bricks were to be laid, to a depth of at least 15" below the water table (door sill). Several laborers soon had the job done, and with the aid of a team and wagon, a course of cinders 8" deep were drawn from a near-by factory.



How a Fire Room Floor was laid.

The accompanying sketch shows where the cinders were placed on the clay. These cinders were slightly wet, and then thoroughly tamped with suitable tamping tools. Upon this course was spread a layer of coarse, sharp sand, about 4" deep at B' and about 2" at B, as is shown. In laying the brick diagonally, as is shown, in part of the fire-room, we found that there was considerable waste in making the broken joints, so when putting in the floor at sides and rear of the boiler, as shown, we laid them straight. A slight sloping of the floor in front of the boilers will be noticed. This was so arranged, that as the ash pits contain water at all times, the water that would naturally come out with the ashes when hauling same, would not form small pools and make things generally disagreeable for the fireman, when cleaning fires.

The heaviest of the work in the fire-room coming on the space between the boiler fronts and the dotted lines shown at FF, we concluded to grout these brick in thoroughly; that is, mix up "clear" Portland cement with water, very thin, and pour in all the joints. As the joints would fill to overflowing, a coarse broom was used to spread the cement all over this space until every joint was filled. This treatment made an excellent job. The floor has been used now for many months and is giving entire satisfaction. I forgot to say that the

brick used are termed "Vitrified" and are indeed very hard, also that the portion of the floor from the dotted lines FF to the outer wall at G was covered with some very fine sand, which was thoroughly tamped and then swept off after the joints were well filled.

Depew, N. Y. C. W. D.

Give the Firemen a Chance.

EDITOR THE PRACTICAL ENGINEER:

I have read the letter by A. K. Bell, in your December number, and think it very good. How many men have left the boiler room for the engine room? Not many! and how many plants pay any kind of wages to firemen? Very few! I was in Utica, N. Y., a few years back, as head fireman. We had 12 boilers in the plant, three to a man. As the wages were $1.25 per day, are you surprised they could not keep firemen? I was in a plant only a few days ago, where they had four boilers and I noticed that the three-way valve on the water column was wired. I asked why this was done and was told it was done so that no one could close them. I was wondering if this was proper and should like to hear what the readers say about it?

Ivoryton, Conn. J. H. S.

Easy if You Know How!

EDITOR THE PRACTICAL ENGINEER:

I was once sent from a machine shop, where I was working as a machinist, to change the motion of a slide valve engine which had a fixed riding cut-off. Before going to the job, the foreman told me that the main valve eccentric was fastened to the crank shaft only with set screws and would not be any trouble to move but that the cut-off eccentric was keyed fast and that I should have to cut a new keyseat on opposite side of crank shaft for cut-off eccentric.

I found everything as he had said and also that the cut-off took place at ½-stroke. I proceeded to set the main valve eccentric, after which I closed the steam chest and told the engineer he was ready to run. He laughed at me and told me that my job was not half done, as the engine would not run at all. Of course, the engine ran all right but a more surprised man you never saw than that engineer. I left him trying to figure out how the engine would run that way.

Kingston, N. Y. M. H. S.

Methods of Laying Down and Figuring Compound Engine Cards.

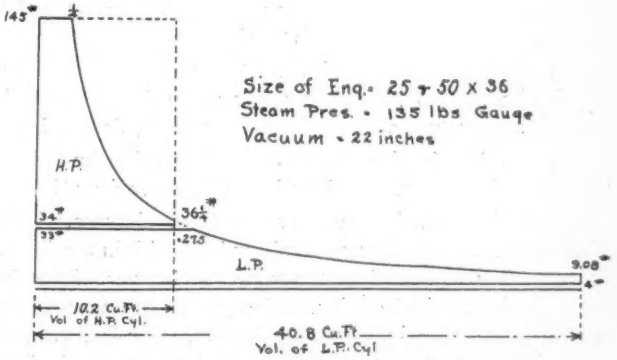
EDITOR THE PRACTICAL ENGINEER:

In reply to the inquiry of A. W. B. E., in the October number, I beg to offer the following answer to Question 1, which was as follows: "Draw the theoretical cards of a compound engine whose high-pressure cylinder is 25 inches in diameter, low-pressure cylinder 50 inches, stroke 36 inches, revolutions per minute 165, steam pressure 135 pounds and vacuum 22 inches. Give and figure out in detail the initial, terminal and compression pressures, points of cut-off on both cards, thermal and mechanical efficiency and steam consumption from the cards."

In the first place, I would say that they must be running their engines in Massachusetts at a tremendous speed, $165 \times 6 = 990$ feet per minute, but as this speed does not concern us at the present time, we will pass over it.

We can assume a cut-off in the high-pressure cylinder at ¼. This gives four expansions in the high-pressure cylinder and as the ratio of cylinders is 1 to 4, the total number of expansions will be $4 \times 4 = 16$. The boiler pressure is 135 pounds gauge or 149.7 absolute. Allowing 4.7 pounds for wire-drawing, gives an absolute initial pressure of 145 pounds per square inch. The absolute high-pressure terminal pressure will then be $145 \times ¼ = 36¼$ pounds and we will assume a high-pressure cylinder back pressure of 34 pounds. If there is one pound loss of pressure between the cylinders, then the low-pressure initial will be 33 pounds. The low-pressure cylinder terminal pressure is then $145 \div 16 = 9.08$; the point of cut-off is therefore at $9.08 \div 33 = .275$ and the number of expansions is $1 \div .274 = 3.64$.

At first glance, this would seem wrong, as we have 4 expansions in high-pressure cylinder and 3.64 expansions in low-pressure cylinder, making $4 \times 3.64 = 14.56$ total number



Theoretically Combined Indicator Cards.

of expansions. This discrepancy is easily explained, as this latter figure indicates the useful expansion while the former number (16) expressed the actual total number of expansions. The difference between the two is expansion into the receiver without doing any useful work and the loss caused by same is shown by the little triangle at the end of the high-pressure card in Fig. 1.

In drawing these diagrams it was only the intention to show a way how to get at it without going into tiresome details. When laying out correct diagrams, the areas of the piston rods and clearances should be taken into account and the proper compression curves should be shown.

I do not see how the mechanical efficiency can be computed from a purely theoretical card, as this depends upon the friction of the engine.

The theoretical steam consumption can be computed from the low-pressure terminal pressure, which gives the weight per cubic foot of steam exhausted. This quantity multiplied by the volume swept through by the low-pressure cylinder per hour, gives the weight of steam per hour consumed. To this must be added a considerable percentage for steam loss which depends entirely on conditions and may run up to 30 per cent.

E. Orange, N. J. F. F. N.

QUESTIONS and ANSWERS

THE editor will be pleased to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Steam and Water Mixtures. Timber Beams. Specific Heat of Copper Ball.

EDITOR THE PRACTICAL ENGINEER:

I would be pleased if you could help me with some problems which I cannot find any rules for:

(1). If 16.7 pounds of steam at 90 lbs. gauge pressure are mixed with 263 pounds of water at 43 degrees, what will be the final temperature of the mixture?

(2). How many pounds of steam at 90 pounds absolute must be mixed with 260 pounds of water at 60 degrees in order that the temperature of the mixture may be 93 degrees?

(3). The length of a round pine timber being known and the weight it must sustain, how is the diameter found?

(4). I wish to find the temperature of my furnace. I took a ball of copper weighing 3 pounds and placed it in the furnace and after it was heated to the same temperature of the furnace, I quickly withdrew it and dropped it into a vessel containing 35 pounds of water at 44 degrees. The final temperature of the water was 65 degrees. I have searched all my books to find a rule to work this but I cannot find any. Can you give me a rule?

Warrensburg, Mo. E. A. S.

(1). The formula for finding the final temperature of mixtures depends upon the formula

$$W(t' - t) = w(T - t') + w\ H$$

in which

W = weight of water.
w = weight of steam.
T = temperature of steam.
t = original temperature of water.
t′ = final temperature of the mixture.
H = latent heat of evaporation.

Since the final temperature of the mixture is required, the formula becomes

$$t' = \frac{Wt + w(T + H)}{W + w}$$

In the given problem, W = 263, w = 16.7, T = 331, t = 43 and H = 880, then

$$t' = \frac{263 \times 43 + 16.7(331 + 880)}{263 + 16.7} = 113.1 \text{ degrees,}$$

which is the final temperature of the mixture.

(2). The formula for finding the weight of steam is as follows:

$$w = \frac{W(t' - t)}{T - t' + H}$$

in which W = 260, T = 320, t′ = 93, t = 60 and H = 888, then

$$w = \frac{260(93 - 60)}{320 - 93 + 888}$$

or w = 7.69 pounds, which is the number of pounds of steam required to raise the 260 pounds of water from 60 degrees to 93 degrees.

(3). If the beam is not very long compared with the diameter, it will break by crushing if the beam is in an upright position. The formula for finding the diameter required when the load is known is

$$d^2 = \frac{P}{.7854\ S}$$

in which P = total load in pounds and S = safe crushing strength which for wood, allowing a factor of safety of 10 is 500 pounds, then

$$d^2 = \frac{P}{.7854 \times 500} = \frac{P}{392.7}$$

$$\text{or } d = .0505 \sqrt{P}$$

that is, find the square root of the load the beam is to carry and multiply the result by .0505. The result will be the diameter in inches.

(4). The method for finding the temperature of the furnace depends upon the formula

$$kw(T - t') = W(t' - t)$$

in which

k = specific heat of copper = .0951.
w = weight of copper ball.
T = temperature of furnace.
t′ = final temperature of water.
t = original temperature of water.
W = weight of water.

Or since the value of T is required, the formula becomes

$$T = \frac{kwt' + W(t' - t)}{kw}$$

in which k = .0951, w = 3, t′ = 65, t = 44 and W = 35; therefore,

$$T = \frac{.0951 \times 3 \times 65 + 35(65 - 44)}{.0951 \times 3} = \frac{18.544 + 735}{.2853} = 2641 \text{ degrees,}$$

which is the temperature of the fire.—[Ed.]

Horse Power and Heating Surface of Boiler.

EDITOR THE PRACTICAL ENGINEER:

I have two horizontal tubular boilers, each 60 inches in diameter and 16 feet long, containing 44 4-inch flues, 16 feet long; shell of boiler is $^5/_{16}$-inch thick, homogeneous fire-brick steel, 60,000 pounds tensile strength; heads of boilers, ½-inch

thick of flanged steel. Each boiler is made of two sheets with seams placed above the fire line and breaking joints. All horizontal seams are double riveted, the rivets being 2 inches from centre to centre for double riveting and 1½ inches for single riveting. Each boiler has an elliptical man-hole in the front head under the tubes and one in the back head over the tubes. Each boiler has a dry pipe in place of dome.

The boilers were tested at 100 pounds hydraulic pressure and approved by the Hartford Company. Safety valve is set at 75 pounds. The area of the grate bars 22.5 square feet. What is the horse power and heating surface of each boiler?

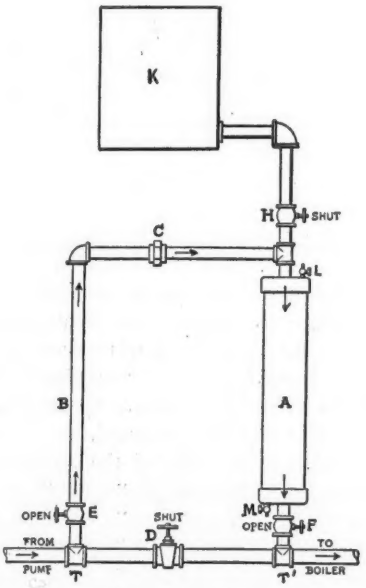
A. W.

Each boiler of the above size will have a nominal capacity of 65 horse power and a heating surface of 975 square feet.—[Ed.]

Method for Feeding Boiler Compound.

EDITOR THE PRACTICAL ENGINEER:

Being a reader of your valuable paper and seeing the troubles of engineers answered, I thought I would write and ask you if there is any way to feed boiler compound between the pump valves and boiler. We have two separate pumps on one line, one being used for washing and other things, and I can't put the compound in the feed line before it gets to the



Arrangement for introducing Compounds into Boilers

boiler pumps. I have tried a small tank but it doesn't all seem to go in and I don't care to waste it. Perhaps you or some brother engineer can explain the best method of feeding it under boiler pressure.

Pittsburg, Pa. W. M.

One arrangement for doing this is shown in the accompanying sketch. The feed pipe is broken between the pump and boiler and the two tees, T and T', and valve D are put in. Suitable pipes and valves are connected at T and T' so that the feed water can be by-passed by closing the valve D. A reservoir at A can be made of pipe and fittings as shown. Tank K is provided for mixing the compound. The operation of the arrangement is as follows:

The reservoir A is filled from tank K by opening valve H and the pet cock L and closing valves E and F and the pet cock M. When A is filled, the valve H and the pet cock L are closed and the valves E and F opened. By closing the by-pass valve D, the feed water from the pump is forced through reservoir A, forcing ahead of it the compound into the boiler. When all the contents of A have been introduced into the boiler, valve D can be opened and valves E and F closed and the process of filling reservoir A from tank K can be repeated. Before filling reservoir A with compound, pet cock M should be opened to allow the water to run out, valve H being closed and the upper pet cock L opened to allow air to enter.

Examination Questions.

EDITOR THE PRACTICAL ENGINEER:

In a recent examination for higher grade license, the following questions and examples were asked, which I would like to have you explain, giving rules:

1. A boiler is 48 inches in diameter and has double-riveted longitudinal seams. What is the shearing strain on rivets, if the boiler pressure is 80 pounds?

2. A boiler 6 feet in diameter has a segment whose base is 56 inches and whose height is 18 inches, braced with 10 braces each having an allowable tensile strength of 6000 pounds. What is the safe pressure?

3. In a compound engine, the dimensions of the high-pressure cylinder are 8" x 12", cut-off $^1/_3$-stroke; dimensions of low pressure 12" x 12", cut-off ½-stroke. How many expansions do you get?

4. An engine with a 36-inch stroke has a valve travel of 4 inches. How much lap is required to cut-off at ½-stroke?

5. With the intermediate cylinder of a triple expansion engine doing most of the work, how can cut-off in either cylinder be regulated to balance the load?

6. Why is steam worked expansively?

New York City. R. E. M.

1. The strain on any longitudinal seam of a cylinder boiler is proportional to the steam pressure and diameter of boiler. In the given case, the diameter of the boiler is 48 inches and the boiler pressure is 80 pounds, so that there is a total shearing strain on the rivets of 3840 pounds per unit length.

2. The area of a segment can best be obtained by referring to the accompanying table. The value of Q in the table is the ratio of the height of the segment divided by the diameter and the area represents the area of a segment with the same proportions, whose diameter is unity, so that if this unit area is multiplied by the square of the diameter of the circle in question, the area of the segment is obtained.

In the given problem, the diameter is 6 feet or 72 inches and the height of the segment is 18 inches; $Q = 18 \div 72 = 0.25$ and by reference to the table, the area of the segment for a circle with unit proportions is .1536. Multiplying this by the square of the diameter, the area of the segment to be braced becomes: $72 \times 72 \times .1536 = 796.24$ square inches. Since there are 10 braces, each having an allowable tensile strength of 6000 pounds, 60,000 pounds is the total allowable strength of the braces, and dividing by 796.24, the number of square inches to be braced, gives 75 pounds per square inch as the safe working pressure.

3. The volume of the high-pressure cylinder is to the volume of the low as the square of their diameters or, as 64 is to 144; that is, the low-pressure cylinder contains 2.25 more volume than the high-pressure cylinder, and since the engine cut-off is at ½-stroke, the number of expansions of the steam is $2.25 \times 2 = 4.5$ expansions.

AREA OF SEGMENTS OF CIRCLES

Q	Area	Q	Area	Q	Area	Q	Area
.100	.0409	.205	.1158	.305	.2028	.405	.2983
.105	.0439	.210	.1199	.310	.2074	.410	.3032
.110	.0470	.215	.1248	.315	.2120	.415	.3081
.115	.0502	.220	.1281	.320	.2167	.420	.3130
.120	.0534	.225	.1323	.325	.2213	.425	.3180
.125	.0567	.230	.1365	.330	.2260	.430	.3229
.130	.0600	.235	.1407	.335	.2307	.435	.3279
.135	.0634	.240	.1449	.340	.2355	.440	.3328
.140	.0668	.245	.1492	.345	.2403	.445	.3378
.145	.0703	.250	.1536	.350	.2450	.450	.3428
.150	.0739	.255	.1579	.355	.2498	.455	.3478
.155	.0775	.260	.1623	.360	.2546	.460	.3527
.160	.0811	.265	.1667	.365	.2594	.465	.3577
.165	.0848	.270	.1711	.370	.2642	.470	.3627
.170	.0885	.275	.1755	.375	.2690	475	.3677
.175	.0923	.280	.1800	.380	.2739	.480	.3727
.180	.0961	.285	.1845	.385	.2787	.485	.3777
.185	.1000	.290	.1891	.390	.2836	.490	.3827
.190	.1039	.295	.1936	.395	.2885	.495	.3877
.195	.1078	.300	.1982	.400	.2934	.500	.3927
.200	.1118						

4. This question cannot be answered unless the angle between the crank and the eccentric or the port opening is known. It can be worked out, however, by means of the accompanying diagram. Since the valve travel is 4 inches, the eccentricity is two inches, and if the angle of advance is assumed to be 60 degrees, cut-off will take place at ½-stroke if the lap is one inch, but the engine will have too much lead. If the angle of advance is taken as 45 degrees, there will be a trifle over 1⅜-inch lap required but it would not give the engine any lead. About 50 degrees angular advance with a 1⅛-inch lap would give the required cut-off at ½-stroke and about the right amount of lead, the maximum amount the port would be opened in this latter case would be ⅞-inch.

5. To decrease the horse power of the intermediate cylinder, make cut-off earlier in the intermediate cylinder and cut-off earlier in the low-pressure cylinder. The effect of cutting off earlier in the low-pressure cylinder is to raise the receiver pressure, thus raising the back pressure in the intermediate and decreasing the horse power in that cylinder.

6. Steam is worked expansively because it is the most economical way of depriving it of its energy.

When the Crank is at 90 Degrees, how Far has the Piston Traveled?

EDITOR THE PRACTICAL ENGINEER:

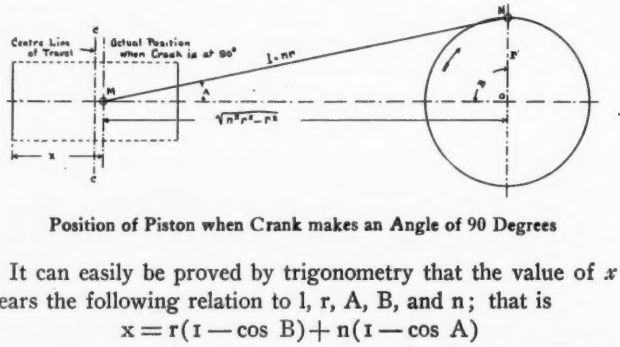
Please answer this little discussion by sketch and figures if your space will allow: "If an engine is on the head end of its stroke and moves forward until the crank pin is at the top or 90 degrees from the centre line of motion, how far along the stroke has the piston traveled?" A said ⅝; B said ½. Which is right?

Manayunk, Phila. C. R.

This whole subject is based upon what is termed the angularity of the connecting rod. If it were possible to construct an engine with an exceedingly long connecting rod, then the distance which the piston would move would approximate half the stroke, when the crank is at right angles to centre line of engine. This never exactly happens unless the connecting rod is infinitely long or a yoke connection is employed between the crank and connecting rod. B is therefore never correct when discussing engines that are actually built and in use today. A is correct only when the dimensions of the crank and connecting rod of a particular engine should happen to bring it to that point.

Referring to the accompanying illustration, it will be seen that while the centre line of the travel of the crosshead CC, which represents mid-stroke, is shown, the actual position of the centre line of the crosshead is in advance of that line and is shown by the line passing through M and is represented as being the distance x from the beginning of the stroke. Just how far x is from the beginning of the stroke depends upon three quantities: the length of the connecting rod, the radius of the crank and the angle the crank makes with the centre line of engine.

In the given figure, $l = M$ = length of the connecting rod, $r = ON$ = radius of the crank, B = angle the crank makes with centre line of motion, A = angle the connecting rod makes with centre line of engine and depends upon the values l and r; x = distance the piston has moved from the end of the stroke and n = ratio of the length of the connecting rod to the radius of the crank.



Position of Piston when Crank makes an Angle of 90 Degrees

It can easily be proved by trigonometry that the value of x bears the following relation to l, r, A, B, and n; that is

$$x = r(1 - \cos B) + n(1 - \cos A)$$

In practice, the value of $(n = l \div r)$ varies from 4 to 8, and since we have the value of B given as 90 degrees, the value of x for the five values of n can be found.

Assume $n = 4$, then $x = .63$ of the stroke.
" $n = 5$, " $x = .61$ " "
" $n = 6$, " $x = .59$ " "
" $n = 7$, " $x = .57$ " "
" $n = 8$, " $x = .56$ " "

That is, in practice, the position of the crosshead will vary from .63 of the stroke to .56 of the stroke when the crank makes an angle of 90 degrees with the centre line of the engine.

Since ⅝ths is .625, it can be seen that party A is only correct in the discussion when the length of the connecting rod is a trifle longer than four times the radius of the crank.—[Ed.]

Riveted Joints.

EDITOR THE PRACTICAL ENGINEER:

Please describe a lap joint and a butt strap joint.

Sault Ste. Marie, Mich. E. B.

The description of lap joints and butt strap joints will be found on pages 6 and 7, September, 1905, issue of THE PRACTICAL ENGINEER.—[Ed.]

Setting Harris Corliss Valves.

EDITOR THE PRACTICAL ENGINEER:

I have a Harris Corliss engine which was built about ten years ago, but I do not know how to set the valves. Will you kindly explain through the columns of your valuable paper?

Chicago, Ill. G. M. R.

The type of releasing mechanism used on the Harris Corliss engine about ten years ago is shown in the accompanying illustration. It consists of the bell crank E, which carries the pawl *e* mounted on a pin. A is the drop lever which carries a short spindle at its lower extremity, to one end of which is carried the collar B and to the other end the curved lever DD. The ends of this curved lever ride on the knock-off cam C.

When the releasing mechanism occupies the position shown in the accompanying illustration, the pawl *e* has just engaged with the lever B and the bell-crank lever E is being drawn in the direction of the arrow by the wrist-plate, thus carrying the drop lever along with it and opening the valve. The pawl *e* remains engaged with B until the right-hand trip lever DD strikes the front of the cam and the other end reached the point M. At this point the catch block B is turned, thus releasing the drop lever and valve.

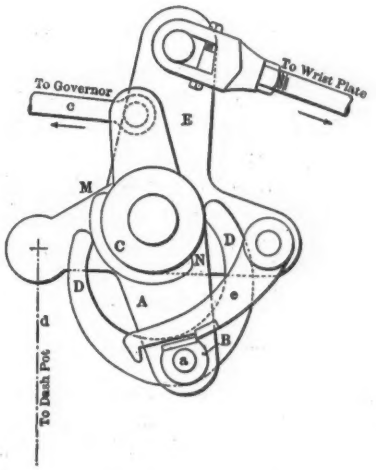
For setting the valves, radial lines showing the opening or working edges of the ports and valves will be found on the back bonnet side of cylinder and back end of valves. For the steam ports, a mark on the cylinder will be found coinciding with that edge of the port towards the end of the cylinder and a mark on the back end of the valve coincides with the edge of the valve towards the end of the cylinder. The lap movement of the steam valve is towards that end of the cylinder in which the valve is located.

The exhaust valve covers or works over the opening from the valve chamber into the exhaust chest and the opening edge is that side of the opening towards the centre line of the cylinder, and has its coinciding mark upon the cylinder. The mark on the back end of exhaust valve shows its opening edge. The wrist plate is located central between the four ports on the front bonnet side of the cylinder, and has marks on the upper side of its hub showing the extremes of its travel and its centre of motion.

To set the valves, place and hold the wrist plate on the centre mark and by the adjusting threads for shortening and lengthening the valve connections, set the exhaust valves at the point of opening and lap the steam valves from $\frac{1}{8}$" to $\frac{3}{8}$", according to the size of the engine, the smaller amount for small cylinders and the larger amount for large cylinders.

Now, connect the wrist plate and eccentric and with the eccentric loose on the shaft, roll it over and note if the wrist plate vibrates to the marks of extreme travel on the upper side of the hub. Adjust at the screw and socket in the eccentric rod, to make it vibrate to the marks. Now place the crank upon either dead centre and roll the eccentric in the direction the engine is to run enough more than a quarter of a revolution, so as to show an opening of the steam valve nearest the piston of from $\frac{1}{32}$" to $\frac{1}{8}$", as required. This port opening at the centre is called lead and more is required in high-speed engines than in slow-speed engines, other things being equal.

Now, tighten the set screw in the eccentric and turn the engine shaft over in the direction it is to run and note if the other steam valve is set relatively the same; if not, adjust by shortening or lengthening its connection.



Harris Engine Releasing Gear.

To adjust the cam rods, have the governor balls resting upon the stop motion pin; then move and hold the wrist plate to one extreme of its throw, and adjust the cam rod for the steam valve, which is now wide open, so as to bring the steel cam on the cam collar in contact with the circular arm of the cut-off hook; move the wrist plate to the other extreme of throw, and adjust the other cam rod in the same manner.

To test the correctness of the cut-off, block up the regulator to about medium height and with the eccentric connected to wrist plate, roll the engine shaft slowly in the direction it is to run, and when the cut-off hook is detached by the cam, stop and measure upon the guide the distance travelled by the cross-head; then continue the revolution of the shaft and note on the guide when the other steam valve is tripped. If cut-off is equalized, then the distance travelled on the guides from each end of the stroke should be the same. If not the same, adjust the cut-off rods until the points of cut-off measure alike.—[Ed.]

Method for Raising Steel Stacks Wanted.

EDITOR THE PRACTICAL ENGINEER:

I would like to hear from some of the boys on the best methods of raising steel stacks, say 30 to 40 inches in diameter and from 60 to 70 feet high, with diagrams of apparatus used; stacks to be set either on smoke box or brick base outside.

Prescott, Wis. C. D.

Reinforcing Rings.

EDITOR THE PRACTICAL ENGINEER:

I would like to ask W. H. F., of Crawford, N. J., how he figures the width of a man-hole reinforcement ring in his formula published in the December issue of THE PRACTICAL ENGINEER? I would like to know what style of man-hole his

formula applies to? Is it applicable to the flat head or to the flange head? I wish to thank W. H. F. for his formula and trust he will explain it in an early number.

Since I now have a rule for finding the width of a man-hole reinforcement ring, I should like to have a rule for finding the thickness. Will some reader contribute one?

Dayton, Ohio. W. E. B.

Correction to Condensing Problem.

A slight error was made in the calculation of the question asked by M. O. N., of Minneapolis, on page 26, January issue. The calculation should be:

$$13{,}580\ (120 - 52) = 960\ (177 - t') + 960 \times 990$$
$$13{,}580 \times 68 = 169{,}920 - 960t' + 950{,}400$$
$$923{,}440 = 1{,}120{,}320 - 960t'$$
$$960t' = 196{,}880$$
$$t' = 205 \text{ degrees.}$$

Testing Engines for Steam Leakage.

In order that all engine tests shall be made according to some standard, the American Society of Mechanical Engineers have recommended the following rules for testing steam engines for leakage:

"The method of testing the valves and pistons for leakage in a Corliss engine or one in which the admission valves can be operated independently of the exhaust valves is as follows: Close the two steam valves, open the two indicator cocks and admit a full pressure of steam into the chest by opening the throttle valve. The movement of the starting bar, first one way and then the other, so as to close one exhaust valve and then the other, causes the leakage through the steam valves to escape fro mthe open indicator cock, where it becomes visible. The quantity of leakage is judged by the force of the current of steam blowing out.

"To test the exhaust valves and piston, the best method is to block the flywheel so that the piston will be at a short distance from the end of the stroke and turn on the steam. The leakage escapes to the exhaust pipe and can be observed at the open atmospheric outlet. If the outlet is not visible and there is a valve in the exhaust pipe, this can be shut and the indicator cock opened, thereby deflecting the steam which leaks and causing it to appear at the indicator cock. In the case of a condensing engine where no atmospheric pipe is provided, and there is no opening that can be made in the exhaust pipe in front of the condenser, some idea can be obtained in regard to the amount of leakage by observing how rapidly the condenser is heated. It is well to make these tests with the piston in different positions, so as to cover the whole range of the length of the stroke.

"Another more approximate method of testing leakage is called the 'time method.' Instead of observing the steam that actually blows through the valves or piston to be tested they are subjected to full steam pressure, and when the parts are thoroughly heated the throttle valve is shut and the length of time observed which is required for the pressure to disappear. In testing the piston and exhaust valves the flywheel is blocked down as before, and, preferably, an indicator is attached and a line drawn on a blank card at intervals of, say, one-quarter of a minute after the valve is shut, thereby making a record of the fall of the pressure. In a tight engine the fall of the pressure is slow, whereas in a leaky engine it is sometimes very rapid. The relative condition of the engine as compared with a tight engine must be judged by an observer, who must, of course, have had experience in tests of this kind on engines in various conditions.

"The leakage of a piston can always be determined by removing the cylinder head and observing what blows through the open end with the pressure of steam behind it. The advantage of the 'time method' is that it saves the labor and time required in removing the cylinder head and replacing it, which, in cases of large engines, is considerable.

"Leakage tests of single-valve engines cannot be made as satisfactorily as those of the Corliss type and other four-valve engines. The best that can be done as regards the valve is to place it at or near the centre of its travel, covering both ports, and then make the test under full pressure. The valve and piston can be tested as a whole by blocking the flywheel and opening the throttle valve in the same way as in other engines.

"In testing compound engines for leakage, the work is somewhat simplified in case of any one cylinder, as compared with a single engine. For example, leakage of the high-pressure cylinder can be revealed by opening the indicator cock on the proper end of the low-pressure cylinder, the steam valve of that cylinder being open. The test of leakage of the low-pressure exhaust valves and piston when the 'time method' is used can be based on the indications of the receiver gauge instead of using an indicator. In that case the fall of the pressure due to leakage is read directly from the gauge.

"The tests thus far referred to are qualitative and not quantitative. It is practical in some cases to determine the quantity of leakage under any set of conditions by collecting the steam which passes through, condensing it and weighing it. This can be readily done when there is a surface condenser, and it can be done in the absence of such a condenser by attaching a small pipe to the exhaust and carrying the steam which escapes into a tank of water and condensing it. How much dependence can be placed upon the results of such a quantitative test as showing the actual quantity of leakage which occurs when the valves and pistons are in motion must be left to the judgment of the person who makes the test.

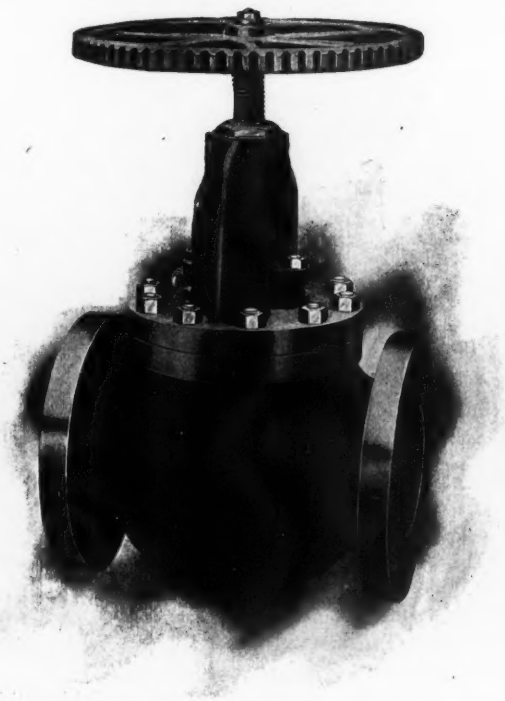
"When full information is desired it is well to test the valves and pistons in several different positions so as to cover the whole range of action. In Corliss engines the leakage of the piston with the engine in operation can be observed by removing the cylinder head, disconnecting the steam and exhaust valves at the head end and setting the engine to work with steam admitted at the crank end."

Jenkins Bros. Extra Heavy Valves.

The use of pressures above 150 pounds has demanded the use of valves which will be perfectly safe under those high pressures and at the same time fulfil their proper functions. To answer this demand, Jenkins Bros. are manufacturing not only extra heavy brass valves up to 3 inches, but have recently placed upon the market their extra heavy iron body valves which are made in sizes from two and one-half to twelve inches inclusive.

The extra heavy brass valves are manufactured in globe, angle, check and "Y" patterns, screwed or flanged. They are designed for 300 pounds working steam pressure, tested to 800 pounds hydraulic pressure and are made from durable steam metal. They are fitted with removable seat rings and have more powerful threads on the spindles. For hydraulic work they can be used on pressures up to 1000 pounds.

The extra heavy iron globe and angle valves are made with even more care, owing to their larger size, the globe valve of this design being shown in the accompanying illustration. Strength and rigidity have been carefully considered in their design and are guaranteed to stand a working steam pressure of 250 pounds. Before leaving the factory, each valve is tested with 800 pounds hydraulic pressure. In sizes larger than five inches they are supplied with a by-pass, which is cast integral with the body, if desired. All extra heavy iron body flanged valves are fitted with the manufacturers' standard for extra heavy flanges and the drilling is in accordance with this



Jenkins Bros. Extra Heavy Flanged Globe Valve

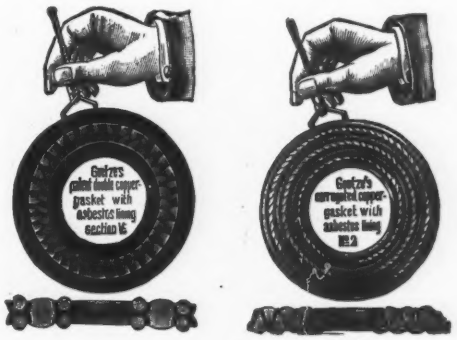
standard unless otherwise ordered. It is advisable to use flanged valves on all sizes above seven inches. For further information, address the manufacturers, Jenkins Bros., 71 John St., New York City.

Goetze's Elastic Profiled Copper and Asbestos Gaskets.

As the use of high temperature and superheated steam has been increasing and as high water and air pressures are becoming more common, there has been a demand for a packing which is safe and reliable.

One of the latest packings which is being made for that class of service is the Goetze packing, shown in the accompanying illustration. Its particular constructive feature lies in the fact that rubber and lead have not entered into its make-up, but it consists of a combination of profiled and corrugated copper gasket and asbestos packing.

The packing is made in two styles as shown, one style mak-



Goetze Copper and Asbestos Gaskets

ing use of a double copper gasket with an asbestos lining between, while the other style uses corrugated joining rings with asbestos lining. The former style finds its best use on lines of pipe where high pressure and superheated steam are used, while the latter style is used where there are likely to be any sudden changes of temperatures and can be used between surfaces which are raw and unmachined.

These packings have been used on long lines of pipe with pressures up to 225 pounds, in many factories and navy yards in Europe and at the recent Dusseldorf Exposition they were used with marked success on all the main steam pipes. They were also in use on steam, water and air pipes in the power plant at the St. Louis Exposition and were reported to give satisfactory service. For further information, address Frederick Goetze, 723 E. 141st St., New York City.

American Boiler Flue Cleaner.

A unique device for boiler room economy which has been put upon the market within the past year is shown in the accompanying illustrations and it is said to have met with hearty approval and acceptance wherever it has been introduced. It is in the form of a permanent equipment for steam power boilers of the fire tube type and has been designed to meet three of the most important requirements of the boiler room, viz.: Reduction of fuel consumption, increase in evaporation of the boiler and reduction of labor required for cleaning flues.

This device, which is known as the American Boiler Flue Cleaner, differs radically from other types of flue cleaners in that it is designed as a permanent attachment to the boiler and therefore ready to do its work at any time. By simply turning a valve, every tube in the boiler is said to be thoroughly scoured out in five minutes by a blast of dry steam and air, while the boiler is under full pressure and operation. By its use, the tubes can be cleaned out every day, which is usually done for five minutes at the end of the day's run or in the morning. The steam that is required is reduced and regulated by gauges.

The accompanying illustration, Fig. 1, shows one of these equipments installed inside of a front combustion chamber and

Fig. 2 shows the method of connection. From a header attached to the boiler head, pipes hang in front of each vertical row of tubes with a syphon jet opposite each tube so placed as to be far enough out from the tubes as not to interfere with

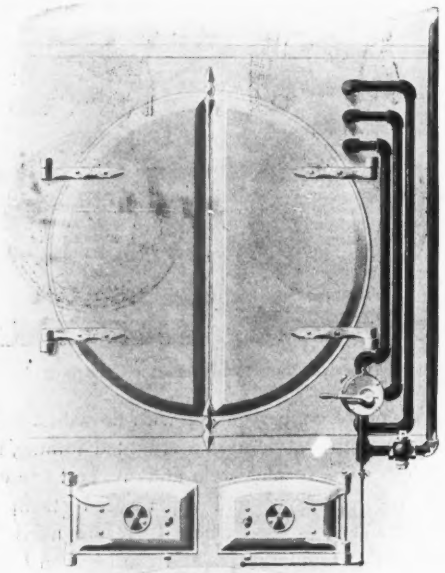


Fig. 1

the passage of gases, and the entire apparatus is adjusted to swing up out of the way when necessary.

The construction of the jets is shown in Fig. 3. They are made of brass, which does not corrode, and are removable. The steam is sprayed from several openings to cover the entire inner surface of the tubes. These jets are constructed for syphon action so as to draw in the air with the steam with sufficient force to clean the entire length of the fire tubes.

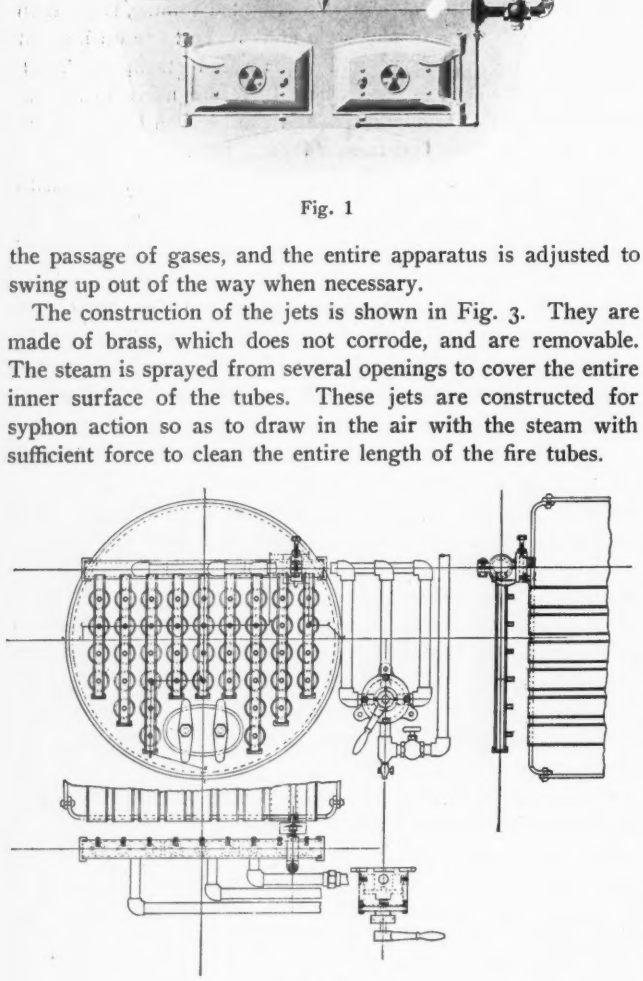


Fig. 2

As shown in Fig. 1, the connection is made on outside front of the boiler from a dry steam line by three feed pipes connected between the header and a three-way cock. When the handle of this cock is turned one notch, the first section of tubes is blown; the second turn blows the next section and likewise the third section is blown. No cold air is, therefore, admitted to the boiler tubes, as the combustion chamber doors are never opened.

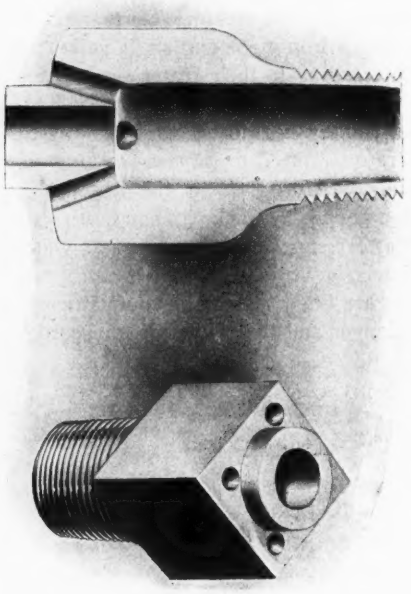


Fig. 3

The American Cleaner has been installed in a number of large plants, where it is said to be giving excellent satisfaction. Further information can be obtained by applying to the manufacturers, The American Boiler Flue Cleaner Co., Broad St., Bank Building, Trenton, N. J., or to their New York agents, Wilkinson & Hackett, Temple Court Building, Beekman and Nassau Sts., New York City.

Book Reviews.

Modern Machine Shop Construction, Equipment and Management, by Oscar E. Perrigo. Size, 7½ x 10½. 32 chapters, 340 pages and 200 engravings. Published by Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price, $5.00.

The aim and object of the author in publishing this book was to produce a work suitable for the practical and everyday use of architects who design, the manufacturers who build, the engineers who plan and equip and the superintendents who organize and direct.

The first part of the book takes up the selection of the site upon which to build, describes the different kinds of soils that may be encountered and how they are dealt with; the different kinds of foundations used and how to construct them; the various methods of building construction of stone, brick, steel, iron and wood taken up separately as to the floor, the walls, the roof, etc. Then the power house, chimney stack, heating and ventilating system, the lighting system and methods of power transmission. The second part of the book is devoted to the equipment of the plant and the third part pertains to the management of the modern machine shop or manufacturing plant.

The book is exceedingly well written, in an easy flowing style, and the illustrations are executed with exceptional clearness, so that it should be a valuable addition to the library of any practical man seeking information along these lines.

Practical Talks on Electricity, by William Baxter, Jr. Size, 4½ x 6½. 47 chapters, 360 pages and 230 illustrations. Published by the Engineer Publishing Co., Chicago, Ill. Price, $2.50.

For the practical man or operating engineer who wants to learn about the electrical machinery used around a power plant, such as dynamos, motors, switchboards, storage batteries, motor controllers, measuring apparatus, etc., the above book should command consideration. The book is divided into two parts, the first part being devoted to the principles and construction of dynamos and switchboards, and the second part to the care and management of dynamos and motors. Among the subjects taken up are magnetism, commutation, types of dynamos, winding of armatures, connections for switchboards and generators, care and management of electrical machines, grounds and short circuits, methods of testing and storage batteries.

The book has one particular objection and that is, the method of indexing. The index for the first part falls in the centre of the book, while the index for the second half falls in the back of the book. This somewhat lessens its usefulness as a reference book and in later editions it should be made to conform with the usual practice.

Practical Pattern Making, by F. W. Barrows. Size, 5 x 7½. 325 pages and 150 illustrations. Published by the Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price, $2.00.

This book is a thoroughly practical work in reference to the methods of making patterns. It is written by a pattern maker of thirty years' experience and contains information on pattern making and pattern makers in general; also a detailed description of the necessary materials and how to use them. The tools used, both hand and machine, are then described, there being special chapters on the lathe, the band saw and circular saw, with examples of work which may be done on these machines. There is a complete section of the book devoted to illustrated examples of wood and metal pattern work, gating and plate work. The work is completed by a chapter on pattern shop mathematics and a chapter on the cost, care and inventory of patterns.

As the author wisely says, he is not a believer in long distance instruction in pattern making, but the book contains many useful facts that are necessarily of great importance to any man taking up that trade. It is concisely written and well illustrated and can be read with profit by anyone who is at all interested in pattern making or its allied trades.

Business Methods in the Engine Room.

An interesting lecture was recently given before Chicago Association N. A. S. E., by James S. Folsom, Chief Engineer of the Chicago U. S. Federal Building, the subject of the lecture being: "Business Methods in the Engine Room." Mr. Folsom believes that the day has gone by when the engineer can afford to devote himself only to the oil-can and monkey-wrench. He is a strong believer that an engineer should also be more or less of a manager or business man. Among the important things which he thinks it is necessary for an engineer to have is a complete series of log sheets, such as a boiler room log, engine room log, pump log, refrigerating machine log, pressure log, temperature log, requisition and time sheets, etc., the number and kind depending upon the kind of plant.

Mr. Folsom then gave many interesting examples of the value of keeping all records around a power plant, especially the record of each individual machine. Mr. Folsom, himself, keeps an account of each machine in his plant and he can tell exactly what each machine cost, how long it has run, how many repairs have been made and the cost of same since the machine was installed; all of which has proved itself to be a most valuable system.

The value of being a business man, Mr. Folsom said, can best be illustrated by one of his experiences, where the question came up as to whether it would be advisable to use incandescent lamps costing 18 cents or 14 cents. The owner of the plant naturally thought that the 14-cent lamp was the cheaper and it was up to him to prove differently. It was shown that the 14-cent lamp consumed 3.5 watts, while the 18-cent lamp consumed 3.1 watts per candle. Figuring the cost of power at 2.1 cents per kilowatt hour, he showed the proprietor that not only was the 18-cent lamp as cheap as the 14-cent lamp, but as the cost was saved in the power rather than in the lamp and as the engines were overloaded, he was the gainer by relieving the engines and generators of their excessive load.

The whole lecture was full of good illustrations and Chicago Association spent one of their most profitable educational evenings in listening thereto.

Lehigh Council.

On January 3d, Supreme Chief Engineer Hiram Trout in-
A. O. S. E., of Allentown, Pa.:

Chief Engineer, Killian Engler; First Assistant, Wm. Comer; Recording and Corresponding Engineer, A. P. Dreisbach, 728 Chew St.; Financial Engineer, A. J. Strauss; Treasurer, John Burley; Chaplain, Joseph Gaven; Senior Master Mechanic, Chas. A. Dreisbach; Junior Master Mechanic, Solomon Fehnel; Inside Sentinel, George Shoemaker; Outside Sentinel, Edmund Brader.

Lehigh Council now has 115 members. Ten new ones were installed during the past term and only two suspended. It is a splendid organization and considering that it is located in a city of but 40,000 inhabitants, it may be classed as one of the most successful engineers' organizations in the country.

Interesting N. A. S. E. Lectures.

The educational work of the N. A. S. E. has been greatly improved this winter by the addition of a number of able lecturers who are visiting the various associations within their circuit. One of the latest additions to the ranks of these lecturers is John H. Foote, of McLeod & Henry Co., who has been giving a series of talks on boiler door arches and fire box blocks to the engineers in the East. Each association visited "want to say to him" that his "talk mixture" has no equal and that he is "it" in the lecturing line.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Thompson Damper Regulator has the power to move the damper or dampers in both directions by water pressure, and is not of necessity wide open or shut. It will close or open the damper or dampers on a variation of one pound of steam; or will make a partial stroke in either direction and stand at any intermediate point between the open and closed positions. One of these regulators will govern from one to twenty boilers by working as many individual dampers, or one or more main dampers. This regulator is more fully described in a circular issued by the makers, Richard Thompson & Co., 126 Liberty St., New York.

A booklet describing the American Boiler Flue Cleaner will be mailed free to any engineer or steam user mentioning THE PRACTICAL ENGINEER. Address, The American Boiler Flue Cleaner Co., 508 Broad Street, Bank Bldg., Trenton, N. J.

That good things often come in small packages is proven in a little booklet issued by the Ohio Blower Co., Michigan St., Cleveland, Ohio. The booklet in question is not large, as booklets go, but it is compact, interesting and even instructive, for it discusses separators sensibly, giving "reasons why" and telling about sizes, capacities, prices, forms of construction, shipping and other things concerning the Swartwout Steam Separator. It is neatly printed in colors and artistically illustrated. It is worth while to write for a copy. Address as above.

One of the finest methods for keeping check on the record of a power plant is to use recording gauges, which tell their story with unerring accuracy. The American Steam Gauge and Valve Mfg. Co., of 208 Camden St., Boston, Mass., are making a specialty of their combined pressure and recording gauges, which are always accurate and never sleep. They record positively and accurately all pressures on a chart, which can be filed for reference and which shows up clearly any waste of steam or fuel. When writing for a catalogue mention THE PRACTICAL ENGINEER.

Readers who are interested in injectors or lubricators of an improved pattern should write for a copy of the new catalogue recently issued by the Ohio Injector Co., 2128 Main St., Wadsworth, Ohio.

A power plant, like any other enterprise, is economical or extravagant according to the manner in which the details are managed. It is the small things that count. The cost of lubrication may not seem great, but if that cost can be reduced fifty per cent., or even ten per cent., the saving will be considerable in a year. It is claimed that the Sterling Force Feed Lubricator will show a large saving over any other method of applying oil to bearings and the claims of the makers are supported by some convincing proof given in their finely-illustrated catalogue, a copy of which they will mail to anyone interested. Address, Sterling Lubricator Co., 3 Frank St., Rochester, N. Y.

The Buckeye Boiler Skimmer Co. have recently sent us eight letters which they received from users of the Buckeye Boiler Skimmer. All these letters are from reliable concerns and all speak highly of the skimmers as a means of keeping boilers clean. This makes the second lot of testimonials that this Company has sent us recently to prove what their skimmers are doing in actual practice. Copies of these letters and a large catalogue showing the skimmers applied to various types of boilers will be sent to anyone interested. Address, Buckeye Boiler Skimmer Co., Colburn Ave., Toledo, Ohio.

C. A. Dunham Co., Marshalltown, Iowa, report a very rapid increase of sales for the Steam Trap which they manufacture. Their product seems to meet the requirements of the most severe services in a way that leaves nothing to be desired.

This concern have given considerable attention to the manufacture of a Cast-iron Trap for Low pressure or Vacuum Heating work—something that would give a positive valve movement regardless of the variations in pressure.

They maintain a corps of engineers whose services and advice are at the disposal of their customers, and anyone contemplating a change or improvement where traps will be required will do well to write to them.

Lippincott Indicators seem to be in demand. The Company states that they recently delivered to the Wells-Fargo Co. a shipment which comprised indicators for Alaska, Canada, Hawaii, Australia, South Africa, Mexico, Danish West Indies, all in one day.

Mr. A. C. Lippincott advises us that he is prepared to make some special prices on their indicator reducing wheel and planimeter for orders placed at once and suggests that a catalogue be sent for. His address is Green and Columbia Streets, Newark, N. J.

"Zena" is a new kind of packing which is said to be excellent. It is manufactured by Randolph Brandt, 38 Courtlandt St., New York City.

The Locke Automatic Engine Stop and Speed Limit System permits the immediate stopping of an engine from any part of the plant and makes a flywheel explosion impossible. In case of accident, such as the breaking of a belt or steam pipe, the engine can be stopped without going to the throttle. If the engine attains an unusual speed, the Locke governor stops the engine immediately.

All this and very much more is explained in a finely printed catalogue issued by the Locke Regulator Company, of Salem, Mass., who will be pleased to send every engineer one of these catalogues if he mentions THE PRACTICAL ENGINEER.

The Kilroy Patent Automatic Adjusting Cylinder Ring is a very simple device, by means of which it is claimed that a saving of 20 to 30 per cent. can be attained by reducing frictional losses and preventing steam leakage. It has been subjected to many tests on steam engines, steam pumps and air compressors and the Company ask for no remuneration until their claims are demonstrated. Any one interested should write to the Kilroy Company, 302 W. 53rd St., New York City.

Oleaqua Hydraulic Compound is a neutral oleaginous mixture, for use in hydraulic elevator systems; it combines with the water in the tank and being carried with the water, lubricates wherever the water touches. It is made by O. F. Zurn Co., 23 and 25 S. Fifth St., Philadelphia. For a limited time Messrs. Zurn Co. will ship to anyone mentioning THE PRACTICAL ENGINEER, a keg of "Oleaqua," all expenses prepaid, with the understanding that if the men in charge of the elevator cars fail to notice an improvement in the running of same within one week after commencing to use the compound, due to better lubrication of the valves and pistons, they will make no charge whatever.

The Philadelphia Hydraulic Works, 1218 Cuthbert St., Philadelphia, make a specialty of repairs to all kinds of hydraulic apparatus. They are experts at this class of work and enjoy a high reputation for general excellence. They also install engines, boilers, pumps or complete plants.

J. E. Lonergan & Co., 213 Race St., Philadelphia, have issued a circular showing the "Jelco" Gauge Glass Cutter, a simple and efficient device for cutting gauge glasses to any desired length. Copy of circular will be mailed upon request to any reader.

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Care and Management of

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By NORMAM H. SCHNEIDER

thoroughly revised and enlarged, with many new diagrams, tables and 137 new illustrations.

A practical book for the practical man, containing a fund of valuable information for those who have to do with Electric plants.

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294 Pages 203 Illustrations

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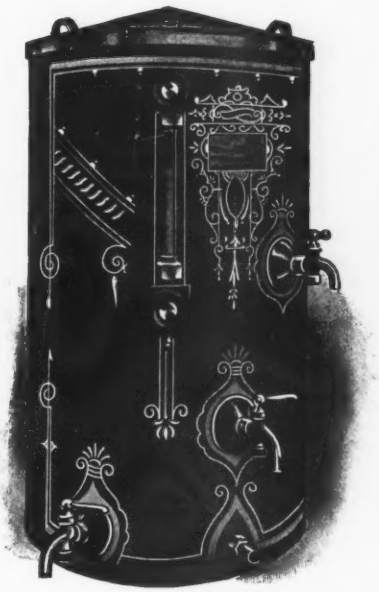
123 P. E. Liberty St., New York

The Cross Oil Filter

enables you to use your lubricating oil over and over. It thoroughly cleans and filters the oil, without affecting its lubricating properties in the least. It might be an interesting experiment to put one in your engine room and then watch the decrease in the oil bill. But the filter itself is no experiment—not a bit of it. We've been building filters too long for that. Many concerns have been using them for twelve or fourteen years. And here's proof that it satisfies particular people:



Providence, R. I., March 25, 1904

BURT MFG. CO., Akron, Ohio

Gentlemen:—We are in receipt of your favor of the 22nd inst. regarding the Cross Oil Filters that we have in our works of your make, and in reply we beg to say that we have used one of these filters in our engine room, for filtering our engine oil, for the past five years, using it every day, and it has never given us any trouble, but does the work satisfactorily. With the hope that this word of recommendation will be of assistance to you, we beg to remain,

Yours truly,

Ordered Two More Recently. BROWN & SHARPE MFG. CO.

There's no manner of doubt about it, you ought to know more about this filter—you can have thirty days' free trial, if you wish. Shall we send you our new 48-page catalog?

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allows nothing but the dryest of dry steam to get out of the exhaust pipe. Where it is used, roofs are not rotted by spray from the exhaust—water does not drip upon the passers-by—Icy sidewalks and the resulting damage suits are prevented. It is built of the best materials, along modern lines, and will last a lifetime.

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Our Burt and Standard Heads

The Burt Manufacturing Co.

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209 Main Street Akron, Ohio, U.S.A.

Also Supplied by Engine Builders, Dealers and Power Contractors

A useful little vest-pocket memorandum book has been issued by the Ohio Injector Co., 2128 Main St., Wadsworth, Ohio. It is substantially bound in black morocco with gold lettering and edges and contains many things of interest to engineers, including colored maps of the United States and our island possessions. It gives some good points about injector troubles and gives directions for connecting injectors; also rules for calculating the speed of pulleys, a page of familiar facts and some useful tables. Those who desire a copy of this little book should send their applications to the above address, together with 20 cents in stamps to cover cost of book and postage.

Readers of THE PRACTICAL ENGINEER who happen to need a new boiler, especially for small plants, will do well to investigate the Gemmel Patent Boiler, built by the General Engineering Co., 764 Swanson St., Philadelphia. This boiler is inexpensive and economical in operation. Moreover, it takes up but small floor space and requires no expensive setting. An illustrated circular will be sent to anyone interested.

The finest piece of advertising literature that has come to our notice this month is a new booklet issued by the A. W. Harris Oil Co., 320 South Water St., Providence, R. I. This booklet treats of lubricating oils for almost every conceivable purpose, and so thoroughly does it cover the subject that there is but little left to be said. It discusses different oils for different purposes and gives reasons why. It is printed in colors on fine coated paper and contains 24 half-tone illustrations. Every reader of THE PRACTICAL ENGINEER should write for a copy before they are all gone.

"Don't Peel a Porpoise with a penknife, Life's too Quick." "One man's meat is another man's poison." "The time to break off the scale habit is before it begins." "You can dock a dog's tail with your teeth but you can't bite off a bull's horns." The quotations given above are from a little booklet which is being sent out by Wilkinson & Hackett, 428 Temple Court, New York. It treats of boiler scale and their way of curing the evil. A copy free for the asking.

Goetze Corrugated Copper Gaskets and Corrugated Jointing Rings made of copper with asbestos lining are illustrated and described in a circular recently issued by the manufacturer, Frederick Goetze, 723 East 41st St., New York. Mr. Goetze will send his entire line of descriptive circulars to any reader of THE PRACTICAL ENGINEER, upon request.

An attractive little mailing cards combining the artistic and the practical has just been published by the De La Vergne Machine Co. The card contains a three-page table of properties of saturated ammonia gas. Anyone interested can obtain a copy upon addressing the De La Vergne Machine Co., foot of East 138th St., New York.

The Palmetto Calendar for 1906 is ready. It is printed in four colors and the design is very ornamental. Every reader of THE PRACTICAL ENGINEER who has not already received one of these pretty calendars should have one to hang in his engine room. The way to get it is to write a postal card request to Green, Tweed & Co., 17 Murray St., New York. They will send you one if you mention THE PRACTICAL ENGINEER.

The National Pipe Bending Co., 157 Lloyd St., New Haven, Conn., have gone to a great deal of expense in getting out their new catalogue of Feed Water Heaters. It is nicely printed on the best quality paper and contains some splendid illustrations. It also gives some information not usually found in catalogues: Details and dimensions; directions for erecting; percentage of fuel saved by heating feed water; method of installing and operating heaters in condensing steam plants and other information of genuine value to engineers. Readers of THE PRACTICAL ENGINEER who desire to obtain one of these catalogues should write at once to the address given above.

The Standard Roller Bearing Co., of Philadelphia, have just started the erection of a new brass and iron foundry, 60 x 125 feet, two stories high. Their large crucible steel casting plant has just started in operation.

Walter L. Flower & Co., of St. Louis, Mo., have removed their offices and warehouses to 312 and 314 South Eighth St., where their facilities are greatly increased.

The Robb-Mumford Boiler Co. has moved from Cambridge, Mass., to its new plant at South Framingham, Mass.

Mr. William Robertson, of the firm of Jas. L. Robertson & Sons, of New York, is now located in Philadelphia in connection with the Eureka Packing factory, at 236-38 Ionic St. Mr. Robertson will represent the complete line of well-known Robertson specialties, including the popular Robertson-Thompson Indicators, Victor Reducing Wheels, Willis Planimeters, Eureka Packing, Hine Eliminators, World Feed Water Heaters, Shaking and Dumping Grates, and numerous other devices of interest and value to every engineer. Mr. Robertson represented his firm here several years ago, when he made many friends among Philadelphia engineers. He now wishes to renew old acquaintances and form new ones. Anyone in need of any of the products of the firm, who desires any information concerning indicators or other specialties, should write Mr. Robertson to the address given above, or call him on the Bell 'Phone, Market—4746.

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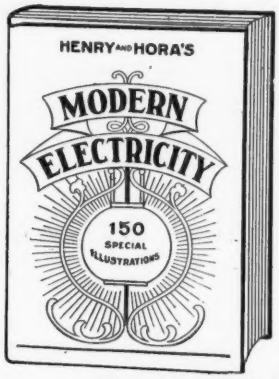

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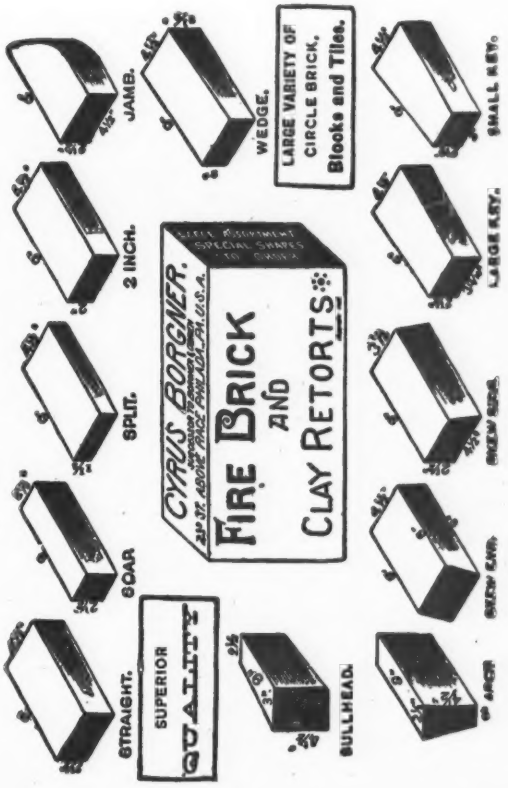

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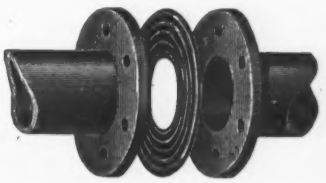

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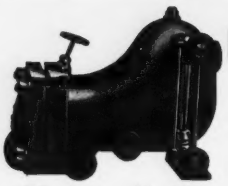

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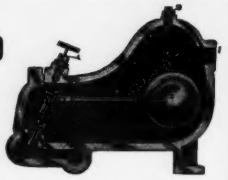

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PALMETTO PACKING will retain its resiliency until absolutely worn out. It will never grip or score a rod.

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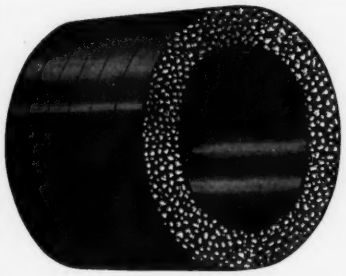

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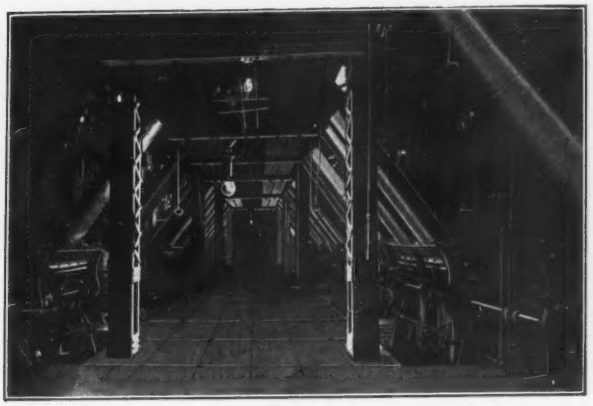

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ALPHABETICAL INDEX TO ADVERTISERS

Acton, John 63
American Injector Co..... 65
American Boiler Flue Cleaner Co.... 64
American Water Softener Co..... 48
Ashton Valve Co..... 56
Audel, Theo., & Co..... 52
Baum, The Separator & Machine Co., 63
Birdsboro Steel Foundry and Machine Co. 53
Borgner, Cyrus 39
Brandt, Randolph 50
Bridgman Bros. Co..... 45
Buckeye Boiler Skimmer Co., The.. 67
Buckeye Engine Co..... 64
Burt, The, Mfg. Co..... 33
Canfield Mfg. Co., Ltd..... 66
Cherry Chemical Company, The.... 52
Collins Regulator Co..... 46
Consumers' Supply Co..... 49
Cook's, Adam, Sons..... 44
Corliss Engine Works..... 45
Davis, I. B., & Son..... 51
Davidson, M. T..... 64
Dearborn Drug and Chemical Works 59
Detroit Lubricator Co..... 54
Direct Separator Co..... 62
Dixon, Joseph, Crucible Co..... 40
Dunham Co., C. A..... 56
Edwards, L. T..... 34
Foster Engineering Co..... 53
France Packing Co..... 47
Frick Company 64
Garlock Packing Co..... 50
General Engineering Co.....45- 63
Genth, F. A..... 34
Golden-Anderson Valve Specialty Co. 57
Goubert Mfg. Co..... 62
Gould Packing Co..... 44
Grapho Mfg. Co..... 34
Greacen-Derby Engineering Co..... 46
Green, Tweed & Co..... 41
Harris Oil Co., A. W..... 49
Harrison Safety Boiler Works..... 61
Hub Machine Co..... 44
Huyette, Paul B., Company..... 53
Indicator Instruction Co..... 60
International Correspondence Schools 53
Jenkins Bros.....Fourth Cover
Just Mfg. Co..... 66
Kelly, Benj. F., & Son..... 60
Keystone Lubricating Co..... 71
Keystone Elevator Inspection and Repair Co. 54
Kieley & Mueller..... 40
Kruger, The, & Blind Co..... 45
Kutztown, The, Foundry & Machine Co. 60
Lagonda Mfg. Co., The..... 43
Laird & Lee..... 39
Lindstrom, John T..... 56
Lippincott Steam Specialty and Supply Co. 60
Livezey, John R..... 72
Lonergan, J. E., & Co..... 49
Lord, The Geo. W., Co..... 51
Lukenheimer, The, Company..... 72
Main Belting Co..... 40
McCarthy, Felix 48
McKnight, Walter J..... 62
McLeod & Henry Co..... 55
McNelley, J. C..... 52
Milligan, William 40
National Pipe Bending Co..... 63
New Jersey Asbestos Co..... 39
New York Belting and Packing Co... 2
Nonpareil Cork Mfg. Co..... 72
Norristown Covering Co..... 1
Nugent, W. W., & Co..... 44
Ohio Injector Co..... 65
Patterson, F. L., & Co..... 60
Patterson Mfg. Co..... 46
Peerless, The, Rubber Mfg. Co., 35, 36, 37, 38
Penberthy Injector Co..... 65
Pennsylvania Electrical and Railway Supply Co. 41
Philadelphia Grease Mfg. Co., The.. 52
Philadelphia Hydraulic Works..... 44
Philadelphia Lubricator & Mfg. Co... 54
Powell Co., Wm..... 57
Quaker City Rubber Co..... 69
Reilly & Fearon Co..... 45
Rich, J. & G..... 45
Robertson, Jas. L., & Sons.....48- 67
Rogers Co., H. A..... 44
Ruwell, W. F..... 45
Smith, W. Clifford..... 40
Smith, Kline & French Co..... 52
Spon & Chamberlain..... 32
Starrett, L. S., Co..... 47
Stayman Mfg. Co..... 57
Stephenson Mfg. Co..... 46
Sterling Lubricator Co..... 54
Sterling Pipe and Blower Co..... 41
Stewart Heater Co..... 61
Thompson, Richard, & Co..... 44
Toomey, Frank 40
Tulley, Henry C., & Co..... 39
Underwood, H. B., & Co..... 68
United States Mineral Wool Co..... 39
United States Metallic Packing Co., The 47
Walsh Packing Co..... 55
Warley & Co., Thos. C..... 42
Watson & McDaniel Co..... 40
Wetzel Mechanical Stoker Co..... 41
Wheeler Condenser and Pump Co., C. H. 62
Whitlock, The, Coil Pipe Co..... 61
Wilkinson Mfg. Co..... 70
Williams Gauge Co..... 58
Worner, O. and W. A..... 40
Wright Manufacturing Co..... 56
Zurn, O. F., Co..... 44

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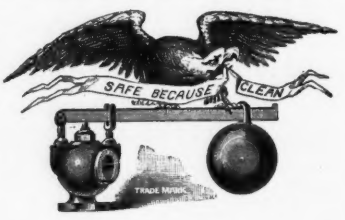
Are prepared from THE HIGHEST GRADES OF CHEMICALS ONLY.
Do not contain anything of an injurious nature to iron or anything in connection with steam plants.
Are GUARANTEED TO FREE BOILERS FROM SCALE AND PREVENT CORROSION and PITTING
Can be used with perfect safety in any kind of steam boiler or plant.



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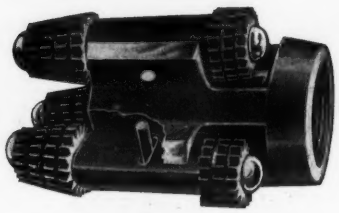

3 Arm Rocker Arm Head.
Self-Adjusting.

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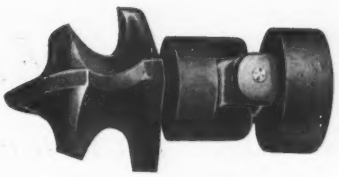

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The Machines that "DO THINGS" to Boiler Scale whether hard or soft, light, medium or heavy. THEY SAVE COAL and INCREASE YOUR BANK ACCOUNT.

The Head is the "Business End" of a Cleaner

See the different Weinland Types, suited to different conditions. Either can be furnished with New Machines or easily attached to any already in use.

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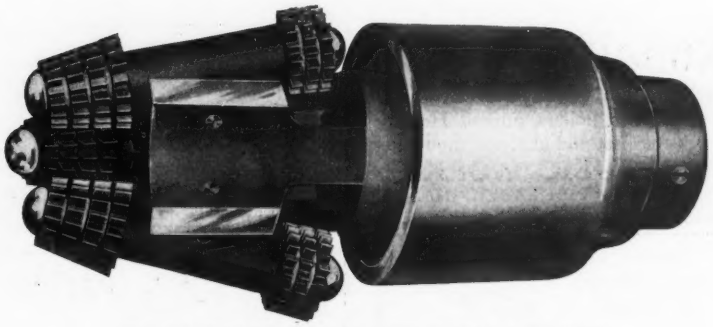

THAN ALL OTHER TURBINE MAKES COMBINED

No. 14 Turbine Cleaner with Rocker Arm Head.

Self-Adjusting at both ends and the middle according to thickness of scale. Can be furnished with either Ball or Thrust Bearings. A model of Simplicity, with fewest parts, most easily and cheaply operated and repaired. Excels in every requirement as to Strength, EFFICIENCY, DURABILITY AND USE OF WATER.

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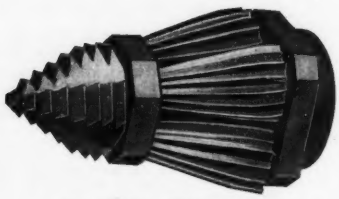

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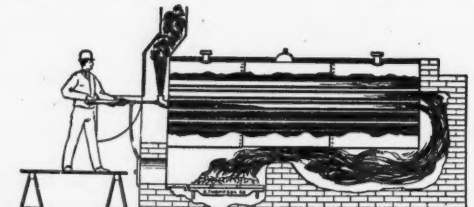

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It goes up Chimney.
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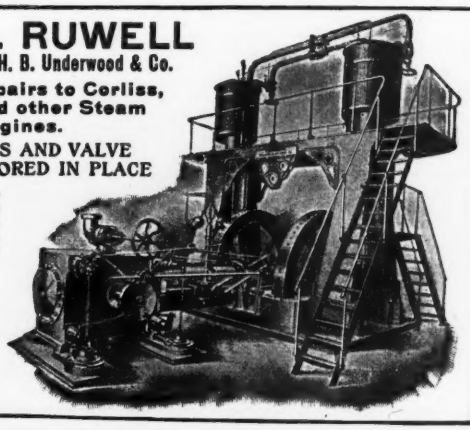

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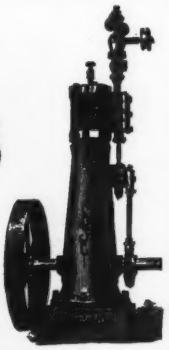

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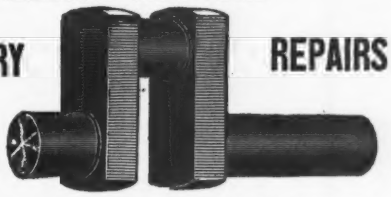

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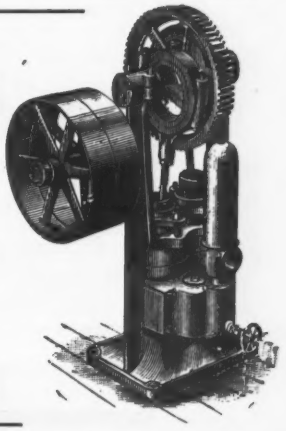

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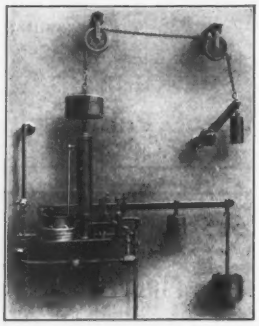

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Satisfaction guaranteed or no pay.

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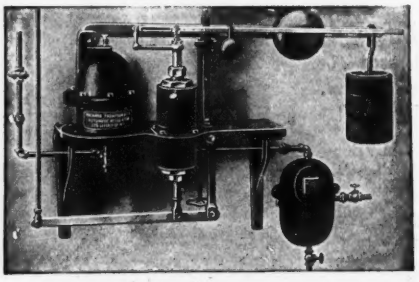

The Thompson Damper and Pressure Regulator is equipped with the very latest and best improvements, and positively insures uniform steam pressure, therefore it saves coal. Don't buy a regulator until you investigate the Thompson, it is the

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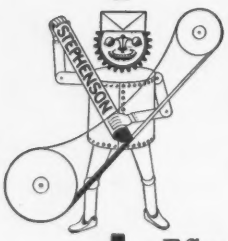

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Clean to handle. Easy to apply.
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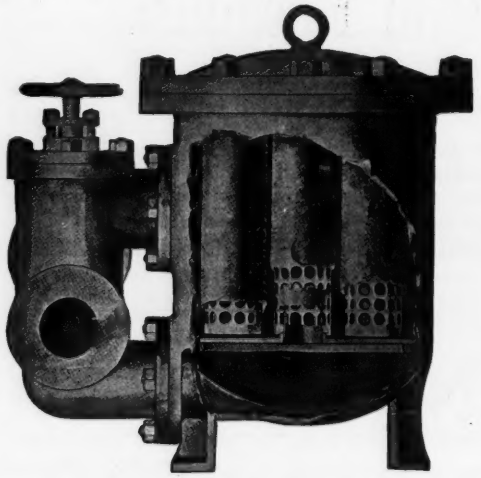
Filtered Feed Water Prevents Scale



The Blackburn Smith Patent Feed Water Filter and Grease Extractor will remove all the mud and grease from your feed water, prevent scale and save you the cost of boiler compounds and wasted fuel. Can be placed either on the suction or discharge scale of feed pump. Easy to clean. Made in all sizes. Write for Catalogue.

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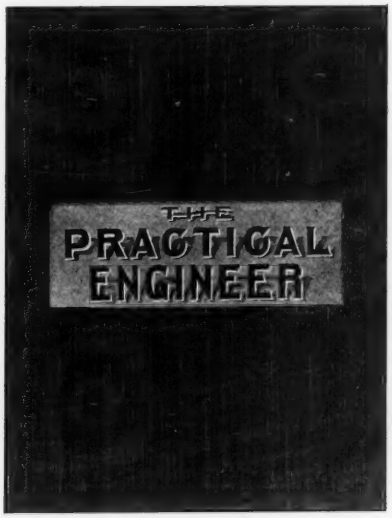

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We are very glad to announce to our subscribers that one of our salesman, Mr Frampton, has perfected a very neat cover that can be used to keep the copies of The Practical Engineer clean and in a usable condition.
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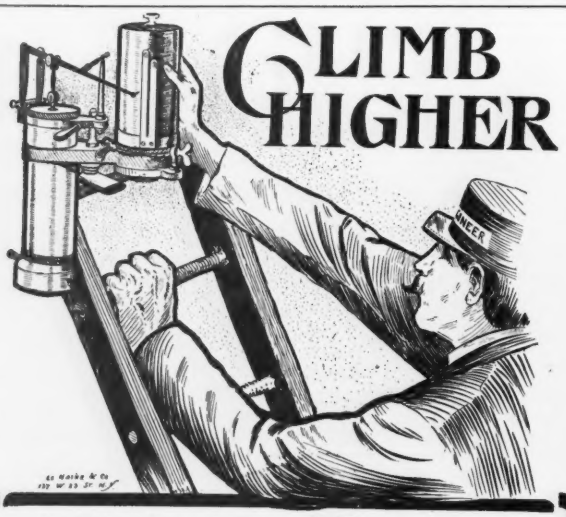

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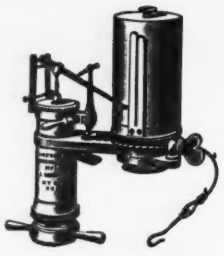

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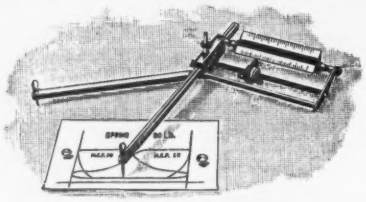

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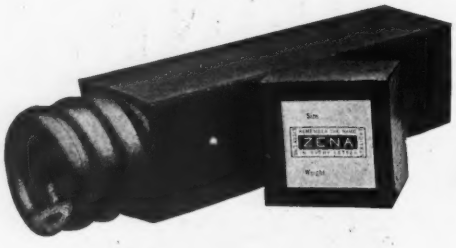

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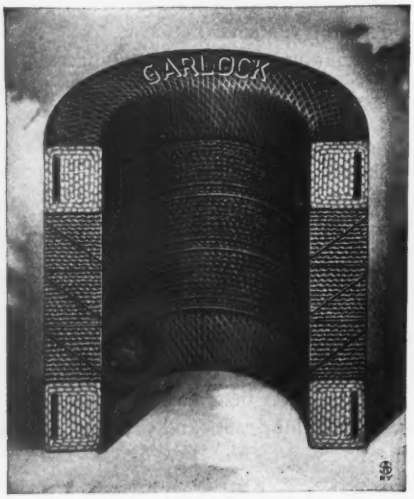

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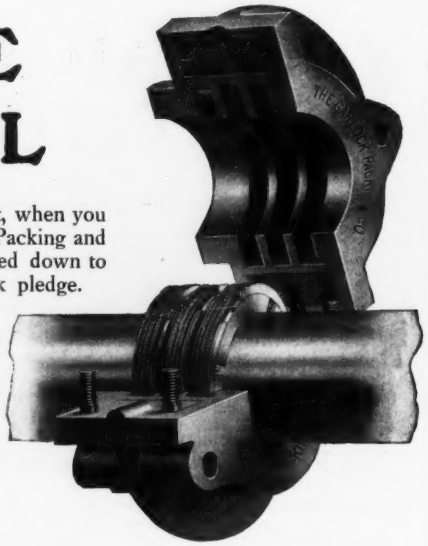

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Then we will send you—free of charge—a high grade pocket knife—two blades—actual size of illustration; also some information regarding

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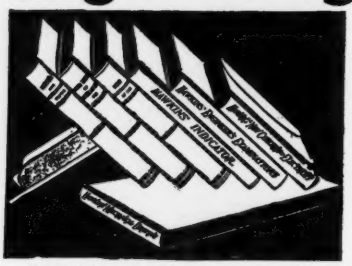
HAWKINS'

Engineering



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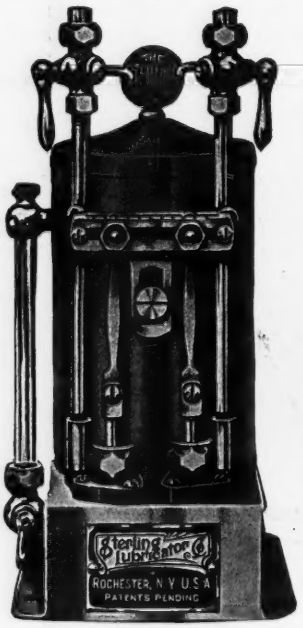

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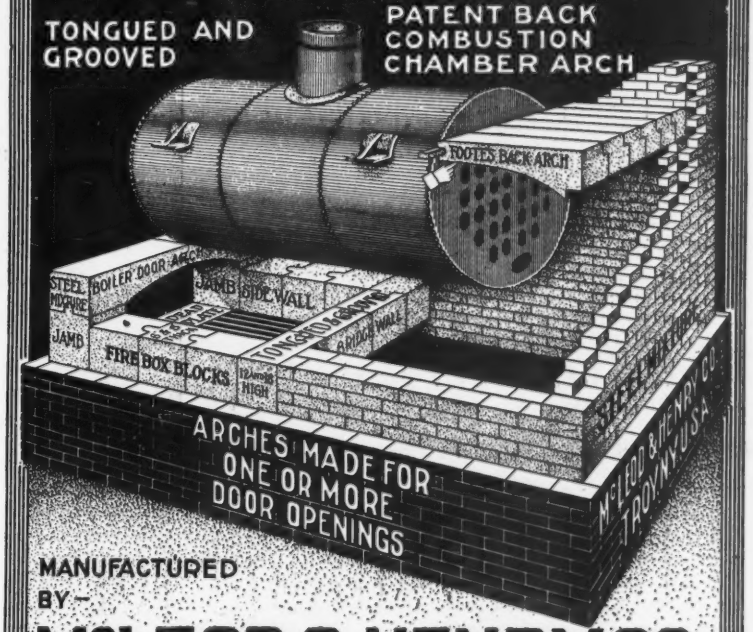

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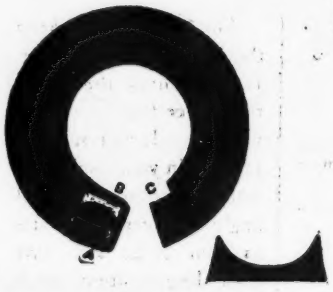

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D—Section of metal cut out at C.

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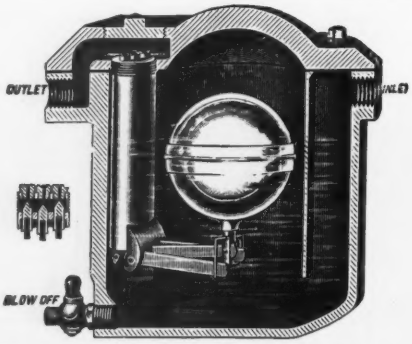
A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets.



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can be trusted at all times, being of a superior quality and guaranteed to give perfect satisfaction.

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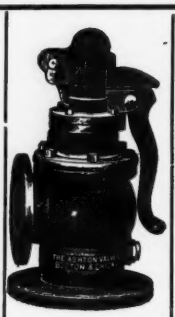

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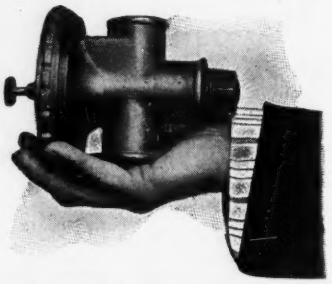

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Circulars "C" on application.

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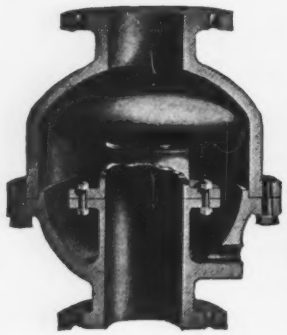

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The newest and best made. It removes the Condensation and Superheats the Steam.

Cylinders Rebored in the Present Position from 4 Inches to 80 Inches in Diameter

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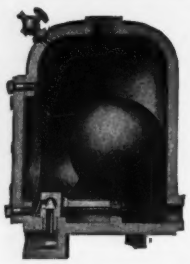
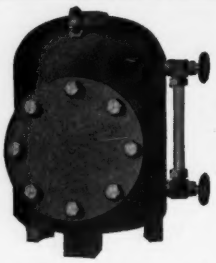


LINDSTROM'S CORLISS VALVE STEAM TRAP THAT NEVER FAILS



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is accepted by Engineers the world over as Standard, embodying every feature that goes to make a strictly first class machine—easily and quickly filled, valves conveniently arranged, separate attaching shank, rigid construction, arms cast in one piece with the body, etc.

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supply a very vital part of the general piping system of **power plants**; the modern power stations and **manufacturing plants, blast furnaces, steel mills** and **mining plants** with their **batteries of boilers** generating high pressures of steam, have necessitated the use of a valve to act **as a safeguard in emergencies.** They will automatically cut off the steam in case of accident to the boilers. "An absolute safety stop."

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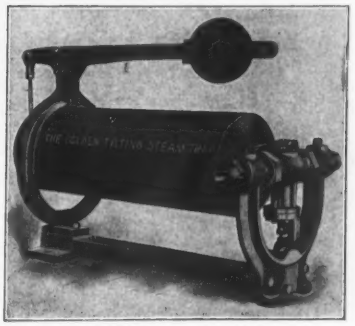
has won for itself an enviable name and reputation. It is a trap of real worth. Simple, positive and durable. It has no floats, valves or buckets inside the trap to cause trouble and expense. All working parts are outside.



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We know these traps have no equal.

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will absolutely prevent leakage with less friction than any other pump piston. The inner spring ring expands the packing ring just enough to give a steam tight fit with a minimum of friction. The packing rings are of a special high-grade anti-friction metal made in interlocking sections. It is self-adjusting and cannot get out of order. It will show high economy in any test. Write for circulars and full particulars.

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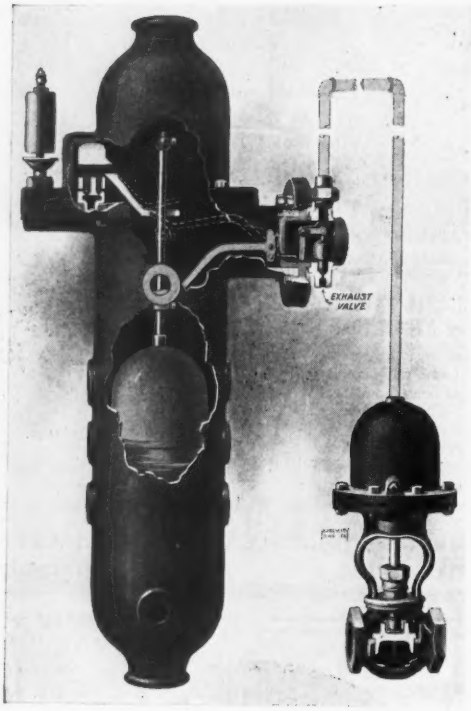
Perfect Protection

Against Accidents and Waste,



is the highest aim of every successful engineer or business man. A reduction in operating expense, means an increase in profits. Immunity from accidents is the prayer of every manufacturer.

The Williams Automatic Safety Feed Water Regulator

insures both safety and economy.

It maintains a uniform water level in the boilers (within half an inch) all the time, thus prolonging the life of the boilers and giving increased efficiency. A uniform water level means dry steam and a fuel economy of from five to as high as fifteen per cent. It saves labor, and saves repairs. With a Williams there is no unequal strains on the boilers, and no one ever heard of a boiler explosion where the Williams was in use.

No boiler plant can be called perfect or even modern without a Williams.

If you are interested in the Williams, write us giving full information, and we will write you the full particulars concerning it, and will send you **Our Handsome New Catalogue Free.**

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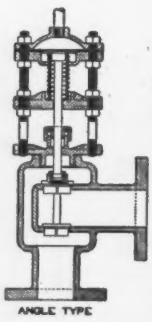
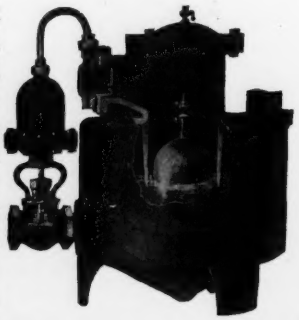


will appeal to the mechanical sense of any engineer at a glance, and it works just as good as it looks. It allows the water to run uniform, and operates in any position. It is made flanged or screwed and for any type of pump. It will operate under any condition on less than two pounds variation, will your governor do that?

The Williams Trap



looks different from others, and so it is. It will keep your steam lines free of condensation. It has a quick acting valve operated by steam pressure. It blows the water out like a shot and closes just as quick

No wire drawing with this trap. If you have any trap troubles it will pay to investigate it.

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When Boilers are scaled, they call for - - - Dearborn
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too much water in the steam—call for - -

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Stands for the Scientific Water Treatment, made to suit the analysis of each water sent us.

"DEARBORN" stands for Treatment that does just what you want it to do.

"DEARBORN" stands for the Treatment that is so thoroughly condensed that you are neither buying nor paying freight on water.

"DEARBORN" stands for the Treatment that absolutely cannot be injurious to heaters, feed pump, piping, boilers or steam connections.

The nature of practically all waters necessitates your using something; if you will find out what all others have done, then investigate what this Company is doing, you will without question, adopt DEARBORN WATER TREATMENT in your Boilers as a permanent solution of the problem.

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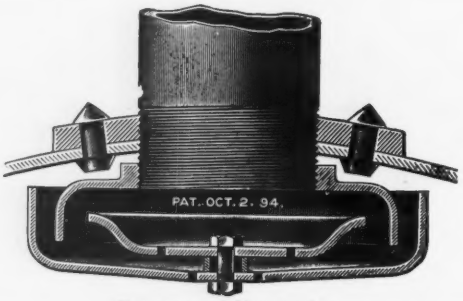
Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.



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Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

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WATER TUBE AND STEAM TUBE

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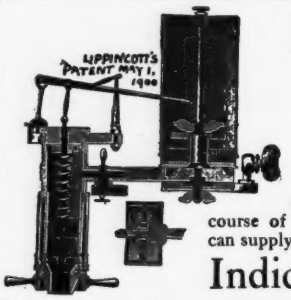

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and in connection with the thorough course of instruction which is given by mail, I can supply you with a fine

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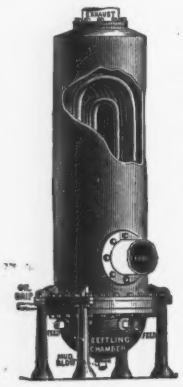

THE PATTERSON-BERRYMAN FEED WATER HEATER AND PURIFIER

will heat the feed water for your boilers to almost boiling temperature without back pressure.

It is easy to clean any time, as the inside of the heater can be reached without disconnecting the heavy exhaust pipes.

The price and trial offer will please you.

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is much more economical than a steam pump, for the extra power from the shafting required to run it is hardly noticed. A steel ball and socket joint is used between the connecting rod and plunger. This joint is easily tightened, thus avoiding the pounding sometimes heard in other pumps.

The prices are right.

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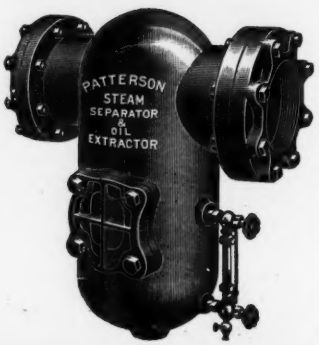
removes the oil and water from the exhaust steam, saves the roofs and prevents complaints from the neighbors. There are no useless baffle plates to create back pressure. Try one in your plant at our expense.

THE PATTERSON STEAM SEPARATOR AND OIL EXTRACTOR

is guaranteed to give satisfaction to the user.

In doing its work a separator must get very dirty. The handhole makes the Patterson easy to clean. Sold on trial at a reasonble price.



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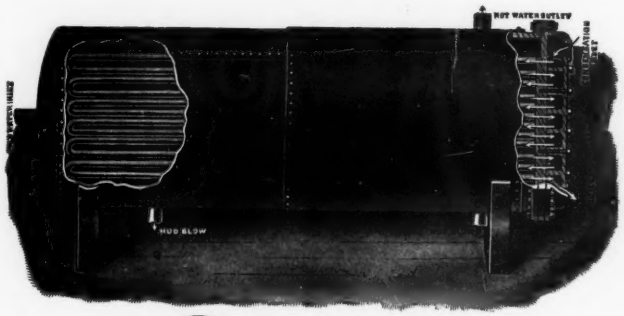

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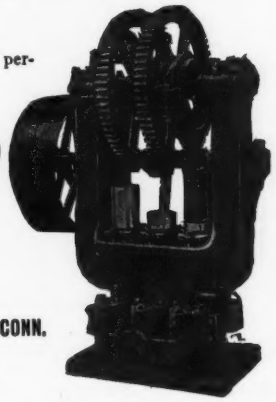
The **Gleaner** represents the acme of perfection in feed water heating.



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Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.

MANUFACTURERS OF
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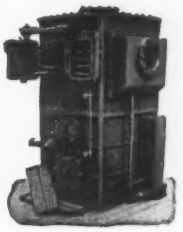

While the service that our Heaters and Systems give is one of vital importance, their cost is nominal—way inside of what the service is worth. The increases in economy and efficiency obtained by using these appliances have in nearly every case **paid for the installation in less than a year.** One of our customers is saving over $20,000 annually on an installation costing less than $5,000.

Let us know what your conditions are and we shall be glad to show just what we can do for you. Meanwhile would you like to have catalogues of our Cochrane Heaters and our Sorge-Cochrane System?

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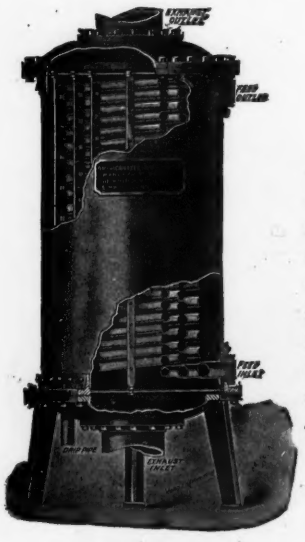
3144 N. 17th St. PHILADELPHIA, PA.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

THAT.S THE KIND OF A HEATER YOU WANT.

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Feed Water Heater, Oil Separator and Purifier is the best oil separator as well as the best feed water heater made. When you buy an Otis you buy satisfaction or you get your money back! and we pay the freight and cartage both ways.

The arrangement of the tubes; the water and oil separator and the cool settling chamber are features that will be appreciated at once by every experienced engineer.

The location of the connections; the "travel" of the exhaust and the ease with which it can be cleaned are features of equal importance.

We Guarantee to heat the feed water to the boiling point (210 or 212 degrees) with the exhaust without causing any back pressure, also to extract the oil from the exhaust

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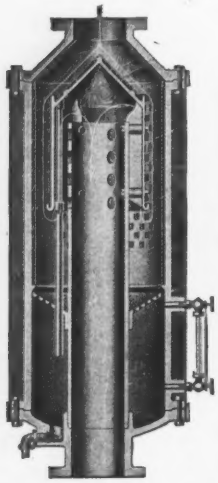

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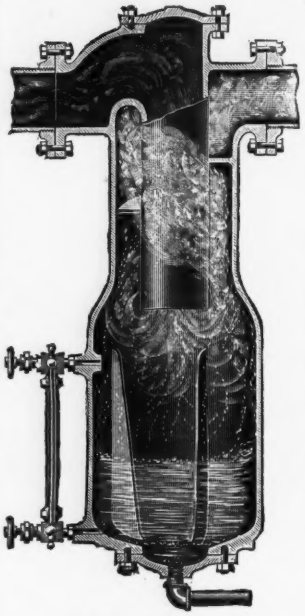

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Separation takes place by the action of centrifugal force imparted to the steam. The large capacity not only provides for a sudden influx of water but forms a reservoir of steam which equalizes the pressure between boiler and engine, thereby increases the power and stops the vibration of steam pipes; a separator of small capacity is worse than useless, it is harmful.

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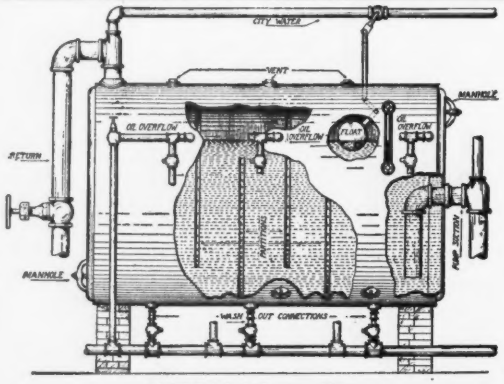

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UNTIL IT IS EQUIPPED WITH THE

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Let us send you our circular. It tells how we handle the condensation from the heating system and the discharge from the steam traps, and separates every particle of oil and grease from the condensation leaving pure clean water to be used over again. It will improve the entire system and will save many times its cost in water, oil, fuel and satisfaction. It will pay you to investigate it.

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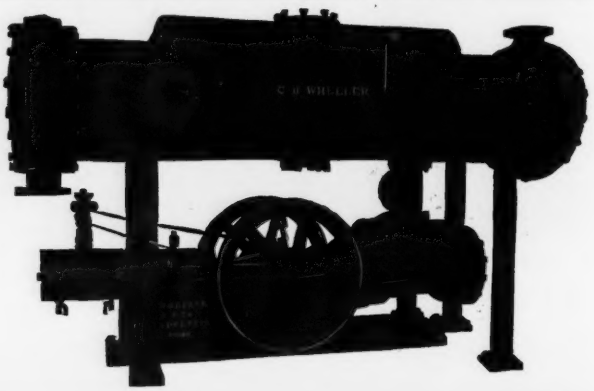

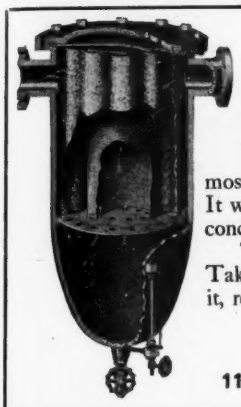

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This Separator represents the latest and most valuable improvements yet discovered. It will take out 95 per cent. of the oil and condensation.

The only Separator that can be cleaned. Take off the top, remove the basket, clean it, replace it and you have a new Separator.

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Horizontal Style for live Steam or Oil Service.

For Live and Exhaust Steam RESULTS GUARANTEED

Repeat orders are the best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and are very much pleased with the results we are getting from it," writes one who has been using Baum Separators for several years.

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Vacuum Style Oil Extractor.

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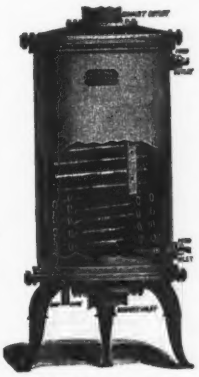
2,500,000 Horse Power in Daily Use



The National

The principal characteristics of these heaters are *Simplicity, Cheapness, Reliability and Effectiveness,* and full amount of heating surface in every heater.

Supplies Water to the Boiler at 212° F.

We manufacture the Original and Only Genuine First-Class Coil Feed-Water Heaters.

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Catalogue and Prices on Application.

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This Vertical Boiler possesses all the advantages of a Horizontal Boiler and none of its expensive disadvantages.

It requires only small floor space. It requires no expensive setting. It affords a natural path for the flue gases, and is a rapid steamer.

Its improved construction guarantees rapid circulation, and the highest degree of efficiency.

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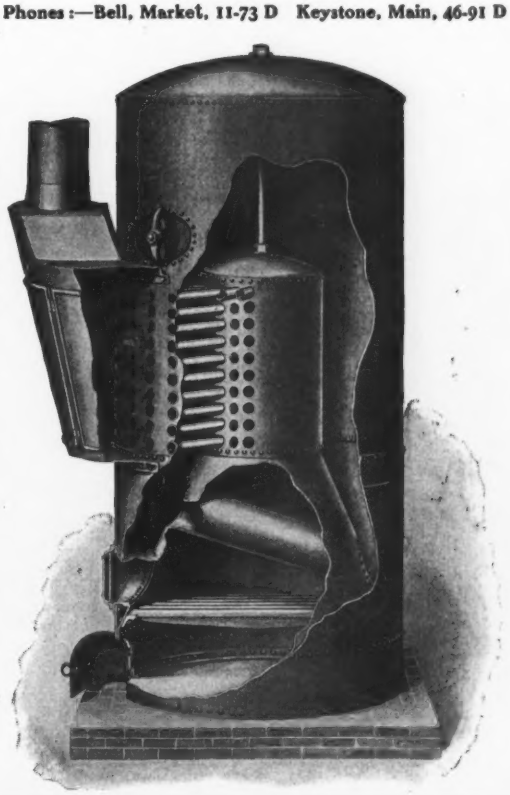

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MACHINE BLACKSMITHING.

Machinery Repairs—Cylinders of Engines and Pumps Rebored in place. Stacks, Tanks and all kinds of Boiler Work.

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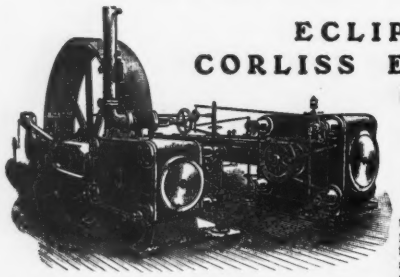

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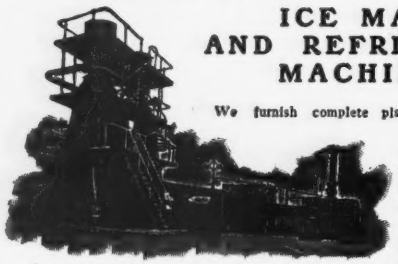
Best regulation and economy guaranteed. Also builders of Steam Boilers. We solicit the furnishing of steam plants complete, including everything. Send for our CORLISS ENGINE PAMPHLET and list of references.



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We furnish complete plants for ice-making and refrigeration for Breweries, Packing Houses, Cold Storage, etc. All refrigerating capacities from 2 to 300 tons; ice-making plants from 1 to 1000 tons per day. We publish a book describing Ice-Making and Refrigeration, which will be sent to intending purchasers.

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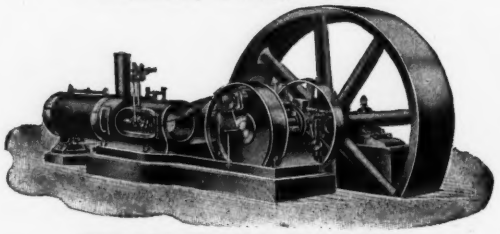

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Material and Workmanship first class in every respect.

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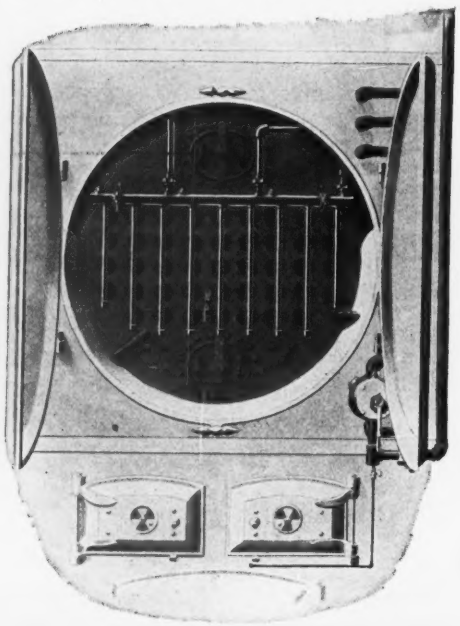
A Perfect Flue Cleaner

That Will Save Twenty Per Cent. Of Your Fuel.



No cold air or condensed steam in the tubes.
Does not effect the steam pressure or the fire.
Can be operated while the boiler is under load.
Gives perfect satisfaction wherever used.

The following is a letter from the General Manager of the Trenton Passenger Railway Company whose entire battery of boilers are equipped with this device :—

JOHN A. RIGG, President PETER E. HURLEY, Gen'l Manager F. W. CROOKETT, JR., Sec. & Treas.

TRENTON STREET RAILWAY COMPANY

American Boiler Flue Cleaner Co. Trenton, N. J., Oct. 21, 1905
Trenton, N. J.

Gentlemen :—

After several months use of your Boiler Flue Cleaner, in our plant, I am pleased to say, that we find them giving perfect satisfaction, and I believe fully meeting all the claims you have made for them.

The first apparatus installed has been in daily use about eight months. The tubes of the boiler have not been brushed or scraped since your apparatus was installed, and we find them in practically as good condition today as at the time of its installation. The same can be said of our entire battery of boilers.

As a fuel and labor saver, your apparatus is emphatically a success, and I think it is entitled to the highest praise. I can cheerfully recommend it to every manufacturer who uses Return Tubular Boilers.

Very truly yours,
(Signed) P. E. Hurley, Gen'l Mgr.

Send For Catalogue

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508 BROAD STREET BANK BUILDING, TRENTON, N. J.

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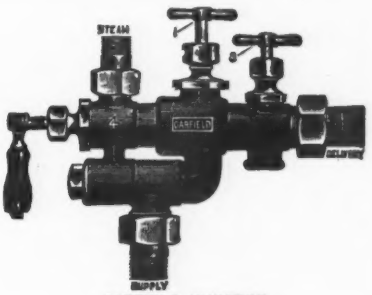
Chicago Injectors

for your boilers and

Chicago Lubricators

for your engines.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They have many advantages and features that appeal to the user.

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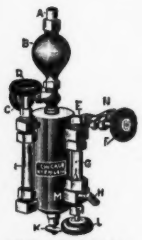
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Before leaving the factory each **U. S. Automatic Injector** is tested under most exacting conditions, on different lifts with various steam pressures.

We guarantee each to work as shown on the "Certificates of Range and Capacity" attached to it.

You don't experiment when you buy a **"U. S."**

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Contains information worth its weight in gold. Send for it. Write to-day.

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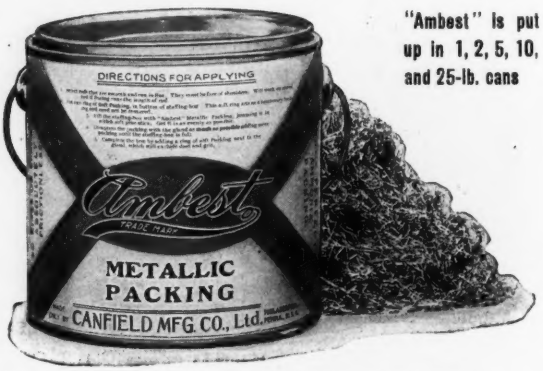
To prove to your satisfaction that we have the most economical up-to-date Metallic Packing, send us your full name and address, by whom employed, number of engines and total horse power, and we will send you for trial, free of all charges, a sample can of

Ambest
TRADE MARK



"Ambest" is put up in 1, 2, 5, 10, and 25-lb. cans

The new and better Metallic Packing; The most perfect Metallic Packing in every way yet produced; No rings or springs. Absolutely frictionless; Simplest and most practical; No waste; Stands highest pressure and speed. Its great special feature and which distinguishes it from all other Metallic Packings, is it adaptability to any stuffing box, or any place, (large or small) where any kind of packing is needed, and all can be packed from the same can;—The smallest steam valve or the largest piston rod.

Hot and cold water, Ammonia, Brine, Oil and Steam,—equally good for all.

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We have established sole agencies with the following firms:—

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Claskin-Comstock Co., Duluth, Minn.	A. H. Gardner Co., Milwaukee, Wis.	Edmund Mather, Harrisburg, Pa.
Kansas City Oil & Supply Co., Kansas City, Mo.	The Salt Lake Hardware Co., Salt Lake City, Utah.	Tatum & Bowen, San Francisco, Cal.
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Do you have a **Brown Core** in your Ice?

WE CAN CURE IT

100 Ice Plants

Use The Just Mechanical Boiler Cleaner
We will show you Why at our expense
Send for Descriptive Matter

Do you have **Scale** in your Boiler?

WE CAN CURE IT

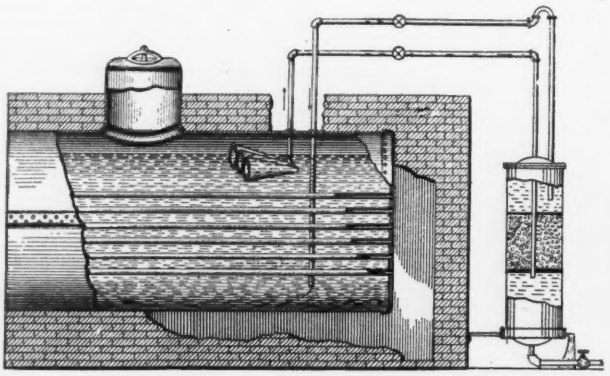
Do Not Spoil Your Output With Boiler Compound

We guarantee that you can run an entire season without shut down to clean boilers when the Just Cleaner is used.

Others Do It
Why Not You

No trouble.
No yearly compound bills.
No burnt tubes or sheets.

TRY US



The Just Mechanical Boiler Cleaner will clean your boilers of scale, will clean your ice of discoloration and

Bad Taste

and will keep right on doing it as long as your plant is in operation.

Give Us a Chance To Prove It

Just Manufacturing Company, 1215 FILBERT STREET, PHILADELPHIA, PA.

How To Keep Your Boilers Clean

The removal of accumulated scale is sure to weaken the boiler. While it's there it consumes additional heat and necessitates overheating the plates. We are preventing scale formation in thousands of boilers working under all conditions and are certain we can keep your boilers clean—so certain that we will let you

Try a Buckeye Boiler Skimmer FREE

Automatically separates scale forming matter permitting only pure water to remain in the boiler. Cheapest method known. First cost is the only cost. Soon pays for itself and then earns money every minute.

The floating Skimmer is always at the water level, and always working to its maximum capacity.

Write us today stating number of boilers and capacity of each, and we will give you some surprising information on scale prevention.

The Buckeye Boiler Skimmer Co.

COLBURN AVENUE

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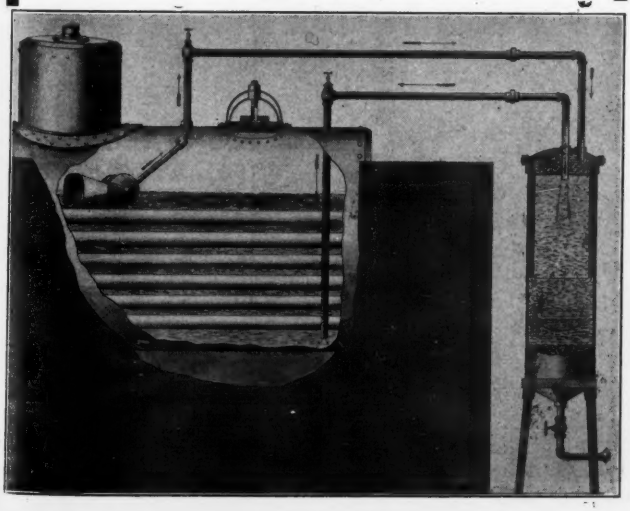

Have you ever had the satisfaction of using the best of its kind?

Eureka Packing

The first engineer that ever tried EUREKA PACKING found it better than the best soft packing he had ever tried. That was nearly a quarter of a century ago. To-day, EUREKA PACKING is still the best soft packing made, and it costs just about half the price of the next best to it.

We use the better kind of flax, the best rubber for the core, and we make it just as good as we know how.

The flexibility, adjustibility and resiliency of EUREKA PACKING will cause it to closely pack a rod without creating friction, and keep it steam tight even when the rod is flat, bent or fluted. It is thoroughly impregnated with a lubricant of high fire test; it is enduringly wear-resistant and an active friction reducent.

Ask your dealer for EUREKA PACKING, and be sure you get the genuine, with the red diamond trade mark.

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If your engine or pump breaks down, day or night, no matter what the conditions are, or where you are located, send for us. We have the largest force of expert mechanics and the largest assortment of special repair tools and machinery to be found anywhere in North America. We send the men and the tools and the machines direct to the job. You don't need to dismantle your heavy engines and pumps, we do the work on the spot.

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Send for our Bock of Useful Hints for Engineers.

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Builders of Dash Pots.
Portable Planer for Facing Off all Sizes of Hammer Blocks in position. All kinds of Steam Hammer Repairs.
Blacksmithing. Steam Power Hammer.

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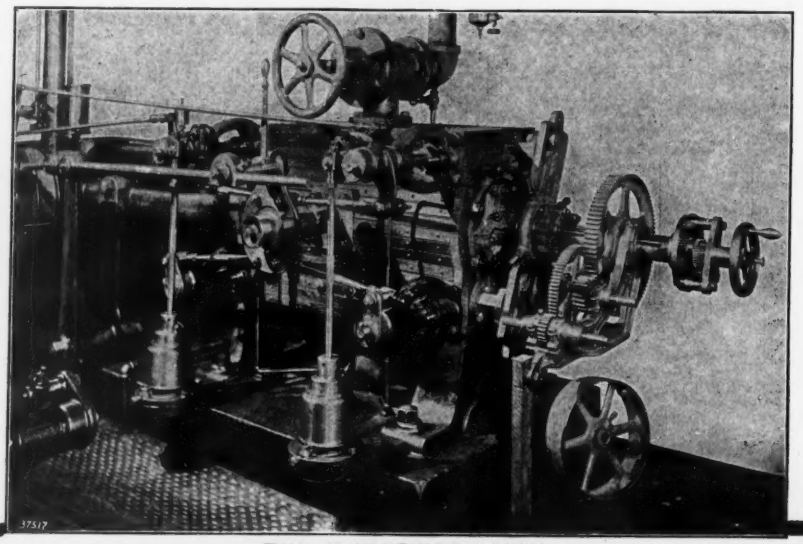

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THE UNDERWOOD WAY

Why be contented with a Packing that has one or two good features when P. P. P. can be credited with TWELVE!

1 It reduces friction decidedly.

2 It lasts far longer than solid packings.

3 It lubricates itself.

4 It gives you no unnecessary trouble.

5 It prevents rod from binding or heating.

6 It fills in scores, and assists rod to work easily.

7 Succeeds where other packings fail.

8 Saves from $104 to $250 a year per rod by saving power.

9 It does not become hard.

10 It saves you from having to pack the stuffing-box every little while.

11 It is not affected by steam, oil, acids, and alkalies.

12 An extra ring is all it requires when worn.

If the packing you use is not satisfactory—if it gives you trouble in one way or another— and soon wears out—try P. P. P. It will surely prove a great improvement. We know it will, for its special construction allows it to overcome the greatest difficulties.

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BY THE USE OF THE

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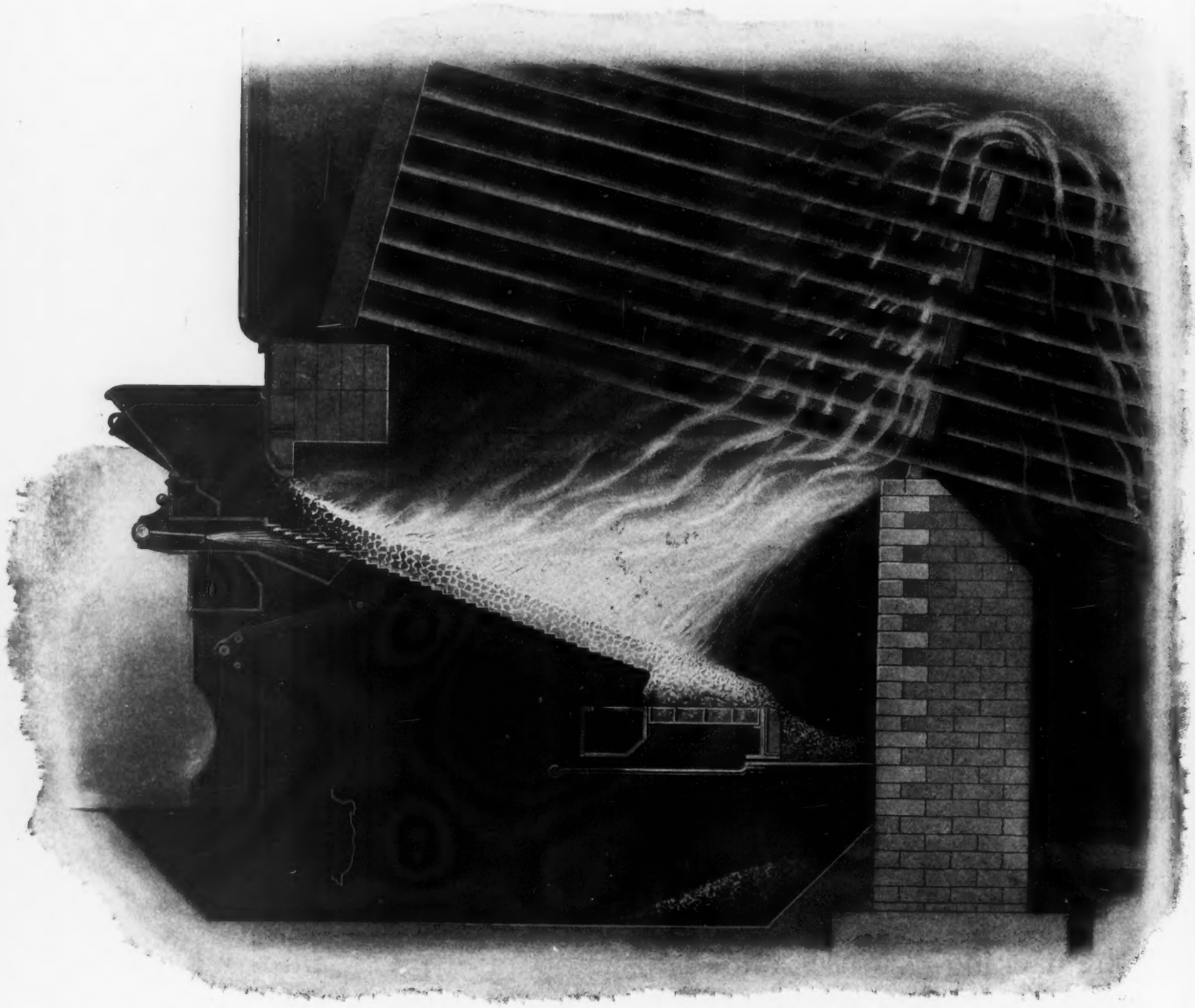

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A Large Can, A Heavy Brass Grease Cup, An Engineer's Cap.

One pound of KEYSTONE GREASE will lubricate better and last longer than 3 to 4 pounds of any other grease or 4 to 6 gallons of high grade oil.

KEYSTONE GREASE will cool any bearing and keep it cool at any speed. Lastingly durable on tight or loose bearings, for light or heavy, fast or slow machinery. Works equally well at any temperature; does not change or spoil by keeping.

Send, with name and business address, size of tap in which cup is to be used, H. P. of engine, and R. P. M.

Keystone Lubricating Co.

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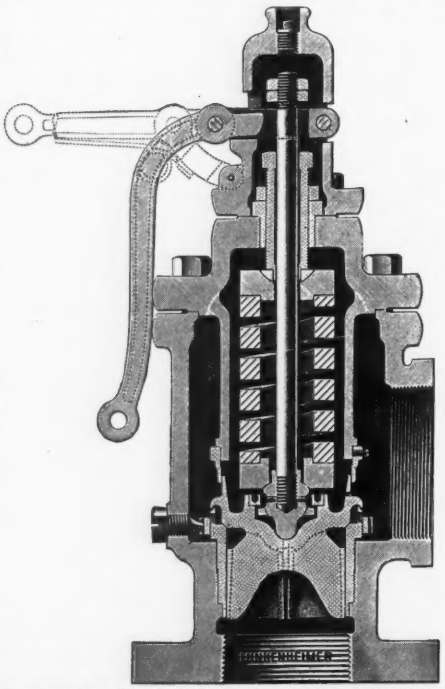

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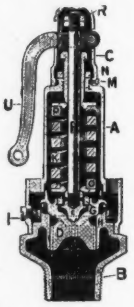
LUNKENHEIMER
Pop Safety Valves

VERY SENSITIVE TO EXCESSIVE PRESSURES

No Boiler Safe without one.
Made entirely of Brass, or Iron Body Brass Mounted, and in Standard Sizes

If Your Dealer Cannot Furnish them, Notify us

The Lunkenheimer Company



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Largest Manufacturers of High-Grade Engineering Specialties in the World.

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For Pipe Covering or Cold Storage Insulation is so much more efficient than other Materials.

It contains no foreign bind, such as pitch, asphalt and shellac, which reduces the efficiency.

In "NONPAREIL" the NATURAL GUM OF THE CORK only is the binder.

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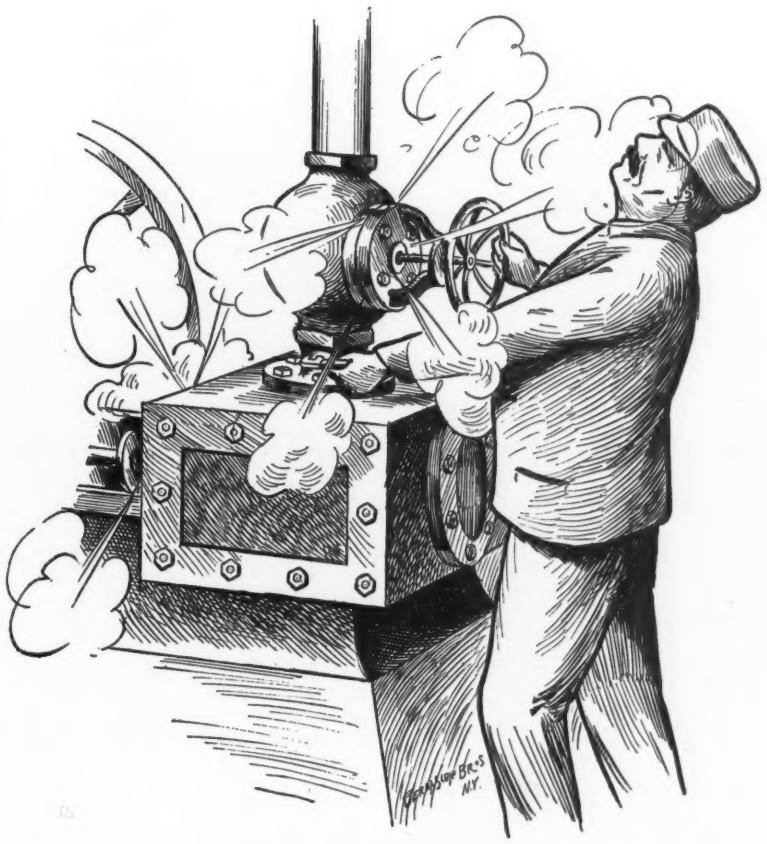
What's the use of trying to stop leaks and blow outs, if your packing is no good.

Use "Indestructible"

and avoid trouble. It resists great pressure.



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For steam, hot water, oil, ammonia, air or cold water joints.
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